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AUTHORITY

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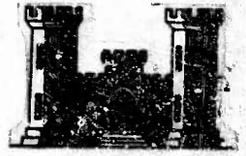
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT.



(11) APRIL 1959,

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T. R. 3-630

report 3

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APRIL 1959

T. R. 3-630
report 3

PREPARED BY THE

GEOLOGY BRANCH - SOILS DIVISION

U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

CORPS OF ENGINEERS

VICKSBURG, MISSISSIPPI

ESERT

ASSOCIATED REPORTS

Date	Title
Feb. 1958	Analogs of Yuma Terrain in the Northeast African Desert (under revision)
Feb. 1958	Analogs of Yuma Terrain in the Northwest African Desert (under revision)
Mar. 1959	Analogs of Yuma Terrain in the South Central Asian Desert

- LIST OF PLATES -

ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

SECTION I: BASIC TERRAIN FACTOR AND ANALOG MAPS

Scope of Study

This folio is the fourth in a series comparing the terrain of the U. S. Army Yuma Test Station at Yuma, Arizona, with other world desert areas. Five copies of each folio-report were prepared. Three copies will be retained at the Waterways Experiment Station and two copies sent to the Special Engineering Branch, Research and Development Division, Office, Chief of Engineers.

The area compared with the Yuma Test Station in this folio is the Mexican Desert.* This desert is conveniently divided into three major desert areas (see fig. 1): (a) the desert of Baja California, which includes all of the peninsula of Baja California with the exception of a small highland area in the northwest and a small tropical zone at the tip; (b) the Sonoran Desert, which borders the eastern shore of the Gulf of California; and (c) the Chihuahuan Desert of central Mexico.

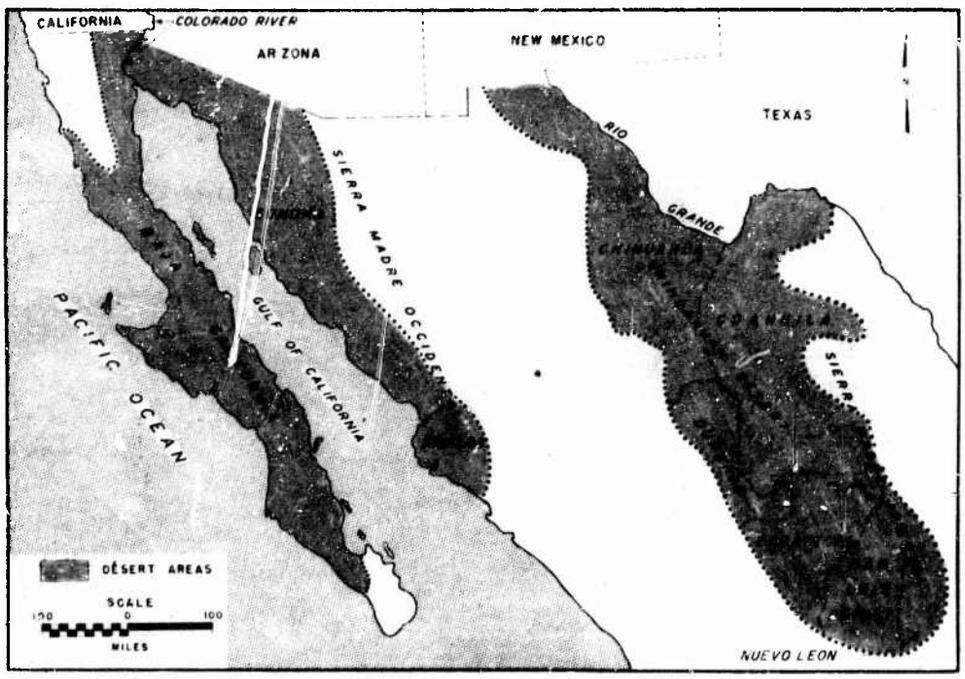


Fig. 1. Mexican Desert

The folio consists of a series of plates, each containing a map of the Mexican Desert with a map of the Yuma Test Station in the upper right-hand corner for easy comparison. Detailed explanations of the mapping procedures used in the preparation of the plates are found in the text entitled Handbook, A Technique for Preparing Desert Terrain Analogs, published by the U. S. Army Engineer Waterways Experiment Station in 1959. Since this folio was begun prior to publication of the Handbook, certain minor differences will be noted between the legends in the Handbook and those in the folio.

Analogy with Yuma

The Mexican Desert terrain is quite similar to that found at the Yuma Test Station. Approximately 67 per cent of the Mexican area is highly analogous, about 26 per cent moderately analogous, and 7 per cent slightly analogous. None of the areas mapped fall in the categories of inappreciably analogous or not analogous.

* Desert boundaries were determined from homoclimatic maps compiled by Dr. Peveril Meigs (Review of Research on Arid Zone Hydrology, published by UNESCO, 1952).

Areas found to be highly analogous are chiefly within mountains, basin-and-range regions, and alluvial plains. The mountain ranges of Baja California, extending along the Gulf of California from the northern desert limit to practically the southern extremity, were found to be highly analogous. Other mountainous areas falling into this category include a small part of the Sierra Madre Occidental in Sonora and a relatively wide band of the Sierra Madre Oriental extending from the Rio Grande to the southern part of the Chihuahuan Desert. The basin-and-range regions of Sonora and northern Chihuahua are a continuation of the Basin-and-Range Province of the United States, and their high degree of analogy, when compared with the basin-and-range physiography of the Yuma region, is to be expected.

Hill lands and desert plains make up the vast majority of moderately analogous areas. Moderately analogous areas in Baja California occur along the coast and, generally, on the western side of the plateau or mountain fronts. Desert plains grouped with random hills in the central part of Sonora, together with narrow plains along the larger streams, were found to be moderately analogous. Parallel-ridge mountains and a large desert plain in the central portion of the Chihuahuan Desert were also found to be moderately analogous.

Slightly analogous areas occur almost exclusively in the southern part of the Mexican Desert. These areas consist of a maturely dissected plateau in southern Baja California, a dissected plateau in southern Sonora, and a rather extensive desert plain in the southwestern part of the Chihuahuan Desert.

The method of analog development depends on comparison of geometry factors (plan-profile, slope occurrence, slope, and relief), ground factors (soil type, soil consistency, and surface rock), and vegetation of the Mexican Desert with the same terrain factors at the Yuma Test Station. Although physiographic types or associated land forms are not considered in determining the over-all analogy, the high degree of analogy between similar physiographic types is striking. For example, mountains, dunes, basin-and-range areas, and desert plains—physiographic types common to both Yuma and Mexico—have been found to be either highly or moderately analogous. Conversely, dissimilar physiographic types, such as dissected plateaus in the Mexican Desert which have no counterpart at Yuma, were found to be slightly analogous. Exceptions to the above relations occur within the study area. The Colorado delta, tidal mud flats along the coast, and a small plateau in northwestern Baja California were found to be highly or moderately analogous, although no physiographic counterpart occurs at Yuma. Some desert plains, similar physiographically to areas at Yuma, were found to be slightly analogous.

It is interesting to note how one factor, vegetation, can influence the degree of analogy of an area. Had the vegetation of Mexico been more nearly similar to that found at Yuma, a high percentage of moderately analogous areas would have been mapped as highly analogous.

Sources of Information

Although considerable published information is available on the Mexican Desert, most of this information concerns detailed geology or stratigraphy of small mining districts. Data on physiography, landforms, and general terrain features are relatively scarce. This is particularly true of the provinces of Chihuahua, Coahuila, Durango, Zacatecas, San Luis Potosi, and Nuevo Leon.

Mapping in the extreme eastern and southern parts of the Chihuahuan Desert is unreliable. Most reliable published information concerns Baja California and Sonora.

Complete map coverage of the area was available from the American Geographical Society of New York and on USAF World Aeronautical charts, both at scales of 1:1,000,000. These maps were most useful in mapping the geometry factors. Maps that were extremely useful in determining the basic soil types and soil consistencies were the U. S. Department of Agriculture World Soil Maps compiled by the Bureau of Plant Industry at a scale of 1:1,000,000. These maps were found to be of limited use in mapping vegetation. The geological map of Mexico prepared by the Mexican Government for the XXth International Geological Congress was the chief source for mapping rock types. The hypsometric map of Yuma was taken principally from U. S. Strategic charts at a scale of 1:500,000, whereas USAF World Aeronautical charts were used for the Mexican Desert.

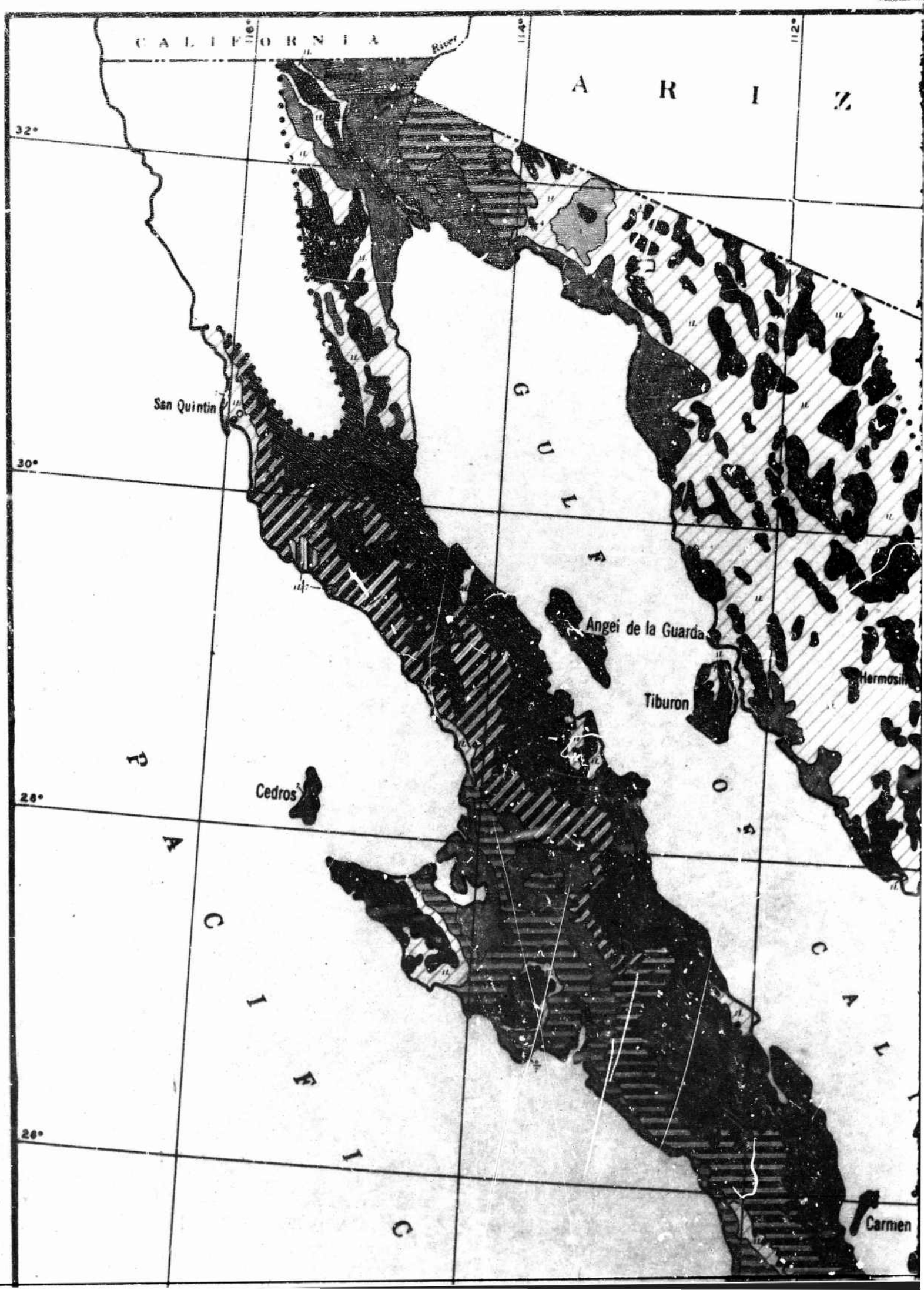
The principal sources of information for the Yuma Test Station were the following: A report, Terrain Study of the Yuma Test Station Area, Arizona, prepared for the U. S. Army Engineer Waterways Experiment Station by Purdue University in March 1955; Handbook of Yuma Environment, published by Office, Quartermaster General, in February 1953 (Report No. 200); and A Study of Desert Surface Conditions by Thomas Clements and others, published by Quartermaster Research and Development Command in April 1957 (Technical Report EP-53).

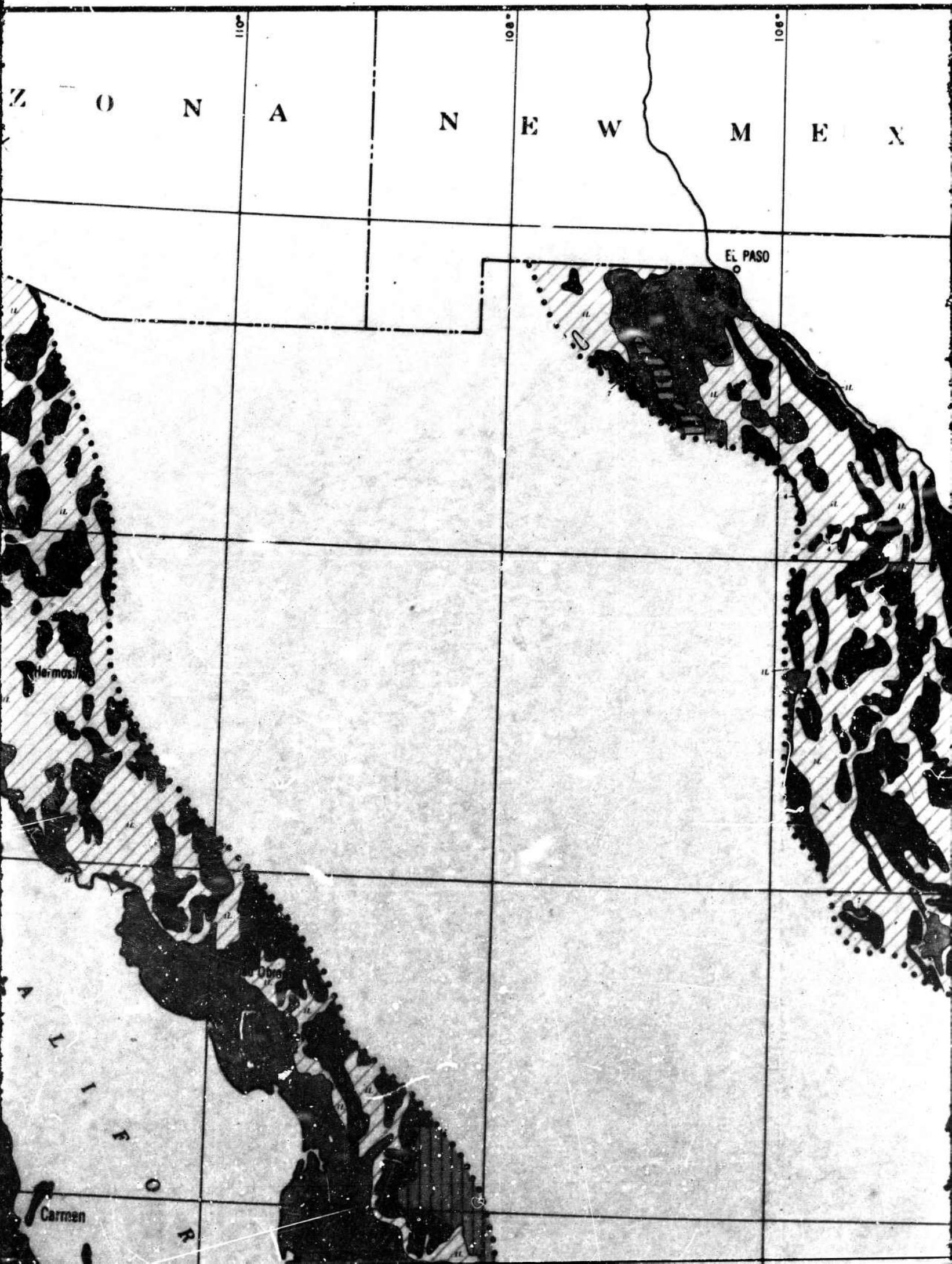
Authorization and Acknowledgments

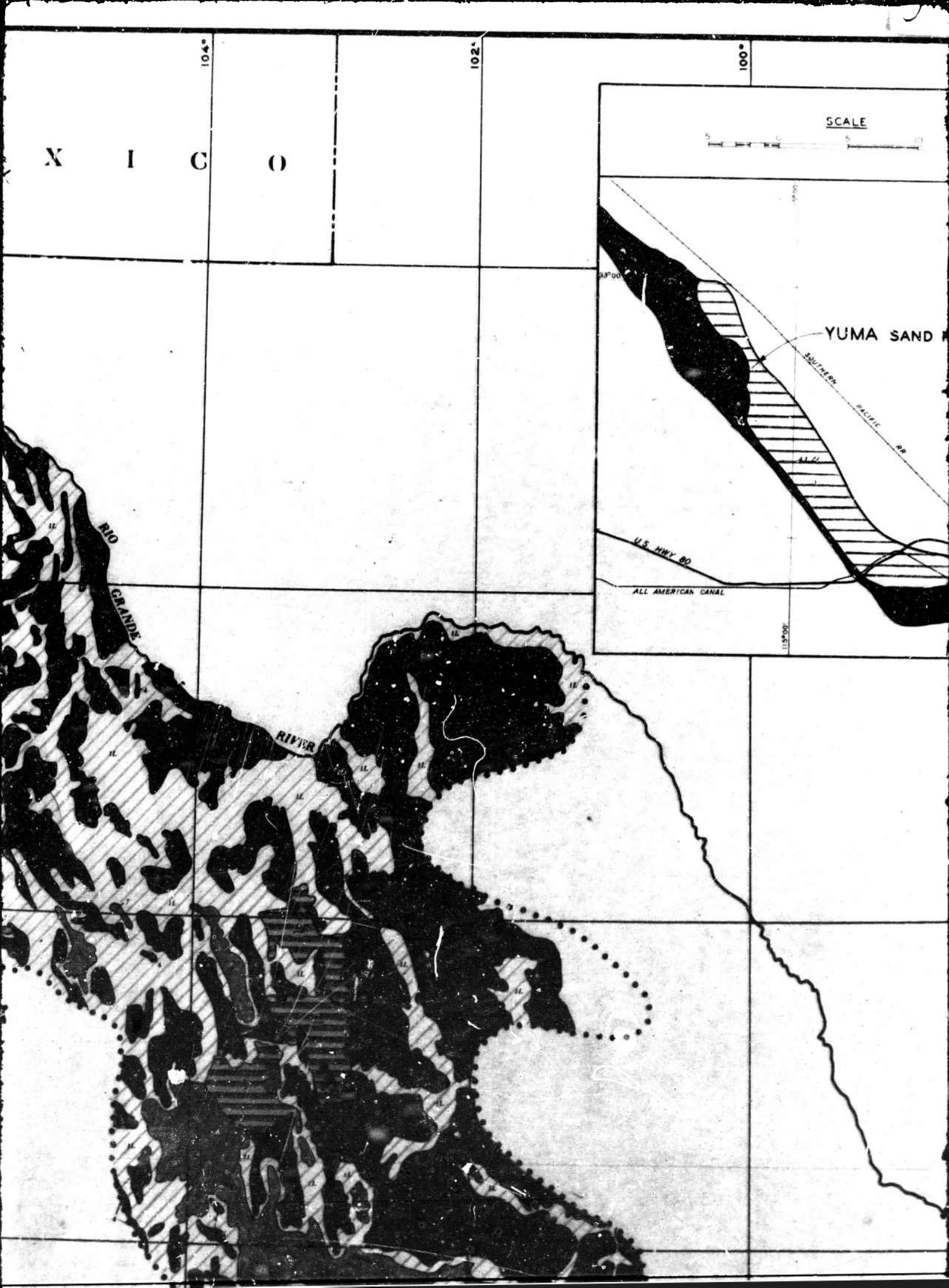
This study is part of Research and Development subproject No. 8-70-09-400, entitled "Military Evaluation of Geographic Areas," which has been assigned to the U.S. Army Engineer Waterways Experiment Station by the Office Chief of Engineers, and is being performed for Office, Chief of Research and Development, Department of the Army. The subproject is directed by the Area Evaluation Section of the Soils Division, Waterways Experiment Station.

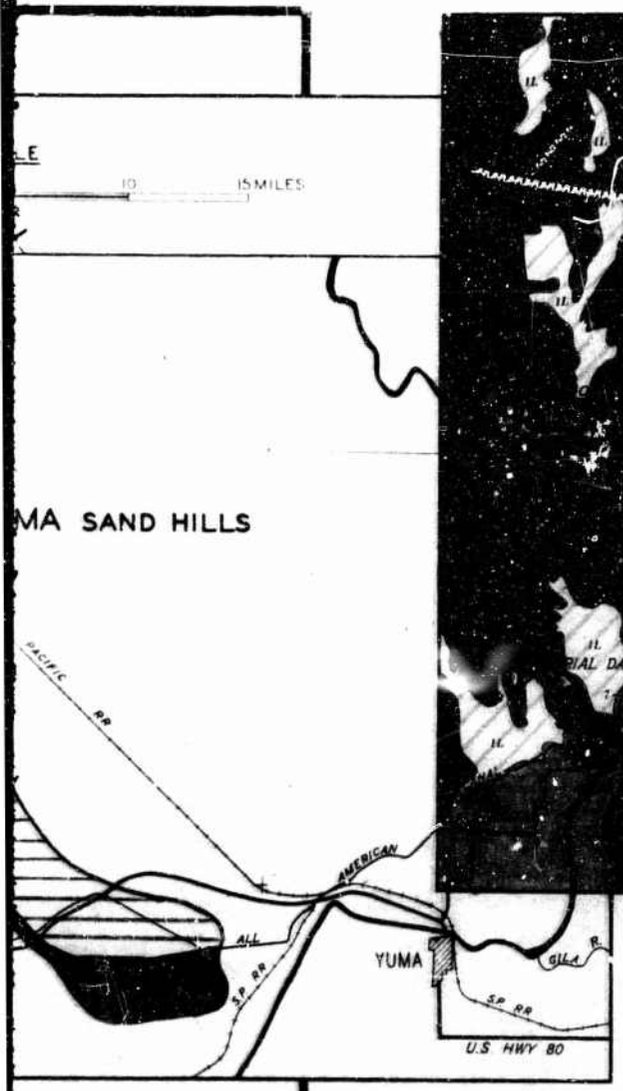
This folio was prepared almost entirely from published reports, maps, and photographs. The literature survey and preparation of most of the preliminary maps — with the exception of the aerial mosaics — were done under contract by the Department of Geology, University of Southern California, and were assembled in the form of an unpublished report entitled Terrain Factor Mapping of the Mexican Desert. The work at the University of Southern California was accomplished by Dr. Thomas Clements, Dr. Richard O. Stone, Mr. S. Sterling Neblett, and Mr. Rudolph C. Pesci. The unpublished report was reviewed and final folio maps prepared by Mr. John H. Shamburger (assisted in the initial stage by Dr. Richard O. Stone) under the immediate supervision of Mr. Charles R. Kolb, Geology Branch, Soils Division, Waterways Experiment Station. Technical assistance was rendered by Dr. Jack R. Van Lopik, Mr. W. K. Dornbusch, Jr., and Mr. Harry K. Woods, Geology Branch, and Mr. Joseph R. Compton, Area Evaluation Section. The project was under the general supervision of Messrs. W. J. Turnbull and W. G. Shockley, Soils Division.

Director of the Waterways Experiment Station during this study was Col. Edmund H. Lang, CE. Technical Director was Mr. J. B. Tiffany.


CALIFORNIA
River
ARIZ
32°
San Quintin
30°
GULF
Angel de la Guarda
Tiburon
Hermosil
28°
Cedros
PACIFIC
CALI
26°
Carmen


Z O N A
N E W M E X
EL PASO
Hermosillo
Obre
A L I F O R
Carmen


X I C O
104°
102°
100°
SCALE
33°00'
YUMA SAND
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
115°00'
RIO GRANDE
RIVER



YUMA TEST STATION

CHARACTERISTIC PLAN-PROFILE

The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either gross or restrictive. A gross plan-profile is one that can be subdivided into two restrictive component plan-profiles each exhibiting relief of a lower order than the gross plan-profile. Random sampling with circles 35 miles in diameter is used in determining the gross profile. Random sampling with circles 1 mile in diameter is used to determine the restrictive plan-profile. Local relief of less than 10 feet is not considered.

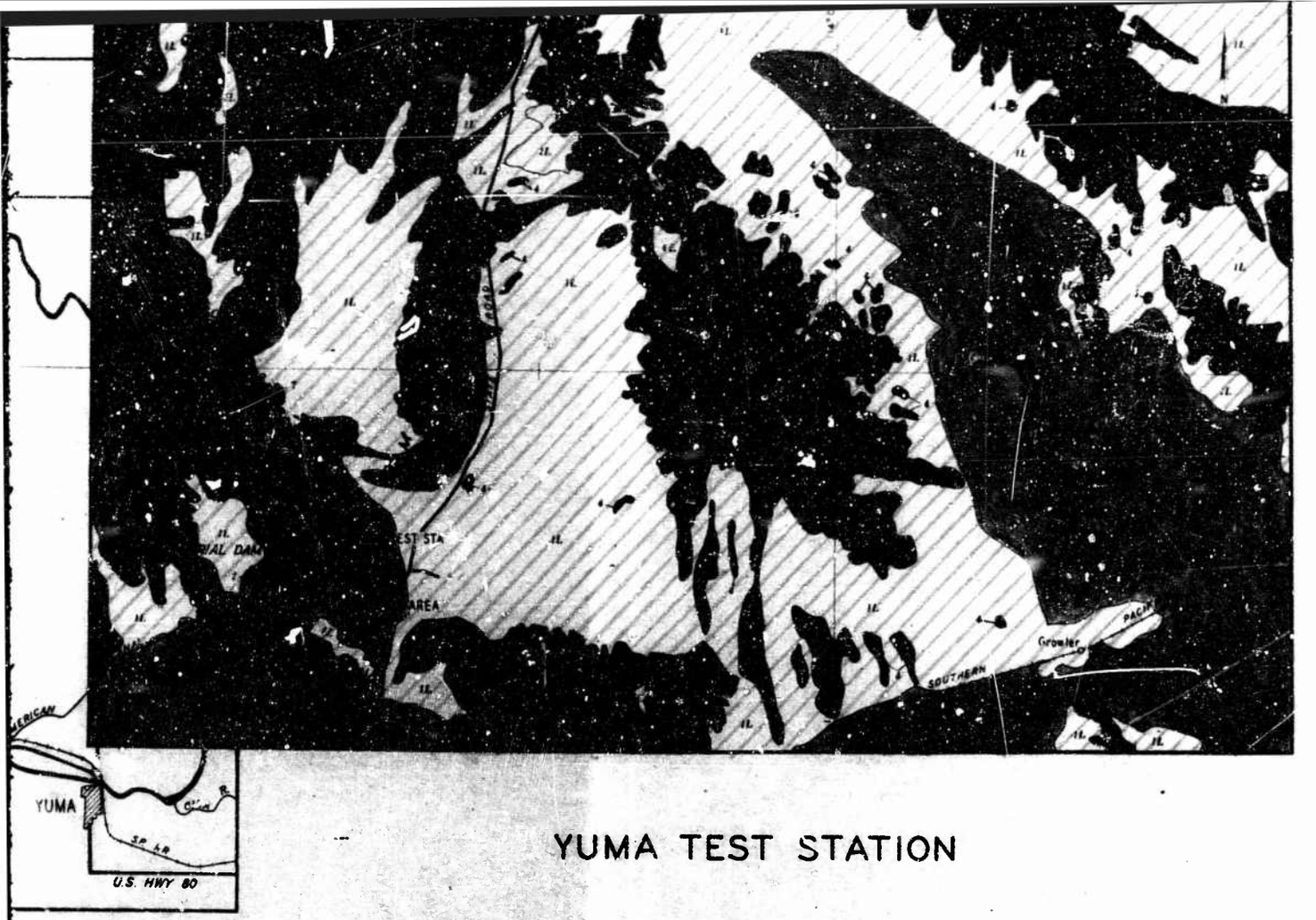
LEGEND

Highs* Occupy:	Highs are → / Schematic Plan / Schematic Profile	Non-linear and Random	Linear and Random	Non-linear and Parallel	Linear and Parallel
>60% of area	Flat-topped	1	1L**	1// ***	1L //
40-60% of area	Flat-topped	2	2L	2//	2L //
<40% of area	Flat-topped	3	3L	3//	3L //
>60% of area	Crested or Peaked	4	4L	4//	4L //
40-60% of area	Crested or Peaked	5	5L	5//	5L //
<40% of area	Crested or Peaked	6	6L	6//	6L //
No pronounced highs or lows		7			

PLAN-PROFILE COMPLEXES:

Areal Complexes: Mapped in areas where two major, areally restricted, plan-profile occur.

1/4 Areally predominant plan-profile of the lows
Areally subordinate plan-profile of the highs



YUMA TEST STATION

CHARACTERISTIC PLAN-PROFILE

The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either gross or restrictive. A gross plan-profile is one that can be subdivided into two restrictive component plan-profiles each exhibiting relief of a lower order than the gross plan-profile. Random sampling with circles 35 miles in diameter is used in determining the gross profile. Random sampling with circles 1 mile in diameter is used to determine the restrictive plan-profile. Local relief of less than 10 feet is not considered.

LEGEND

Highs* Occupy:	Highs are → / Schematic Plan / Schematic Profile	Non-linear and Random	Linear and Random	Non-linear and Parallel	Linear and Parallel
>60% of area	Flat-topped	1	1L **	1// ***	1L //
40-60% of area	Flat-topped	2	2L	2//	2L //
<40% of area	Flat-topped	3	3L	3//	3L //
>60% of area	Crested or Peaked	4	4L	4//	4L //
40-60% of area	Crested or Peaked	5	5L	5//	5L //
<40% of area	Crested or Peaked	6	6L	6//	6L //
No pronounced highs or lows	—	7			

PLAN-PROFILE COMPLEXES:

Areal Complexes: Mapped in areas where two major, areally restricted, plan-profile occur.

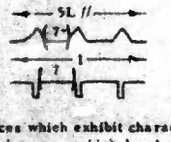
1/4 — Areally predominant plan-profile of the lows / Areally subordinate plan-profile of the highs

1/4 — Areally predominant plan-profile of the highs / Areally predominant plan-profile of the lows

Gross-component Complexes: Confined to areas where a gross and a component plan-profile are mapped.

5L // / 7 — Gross plan-profile / Plan-profile of component lows

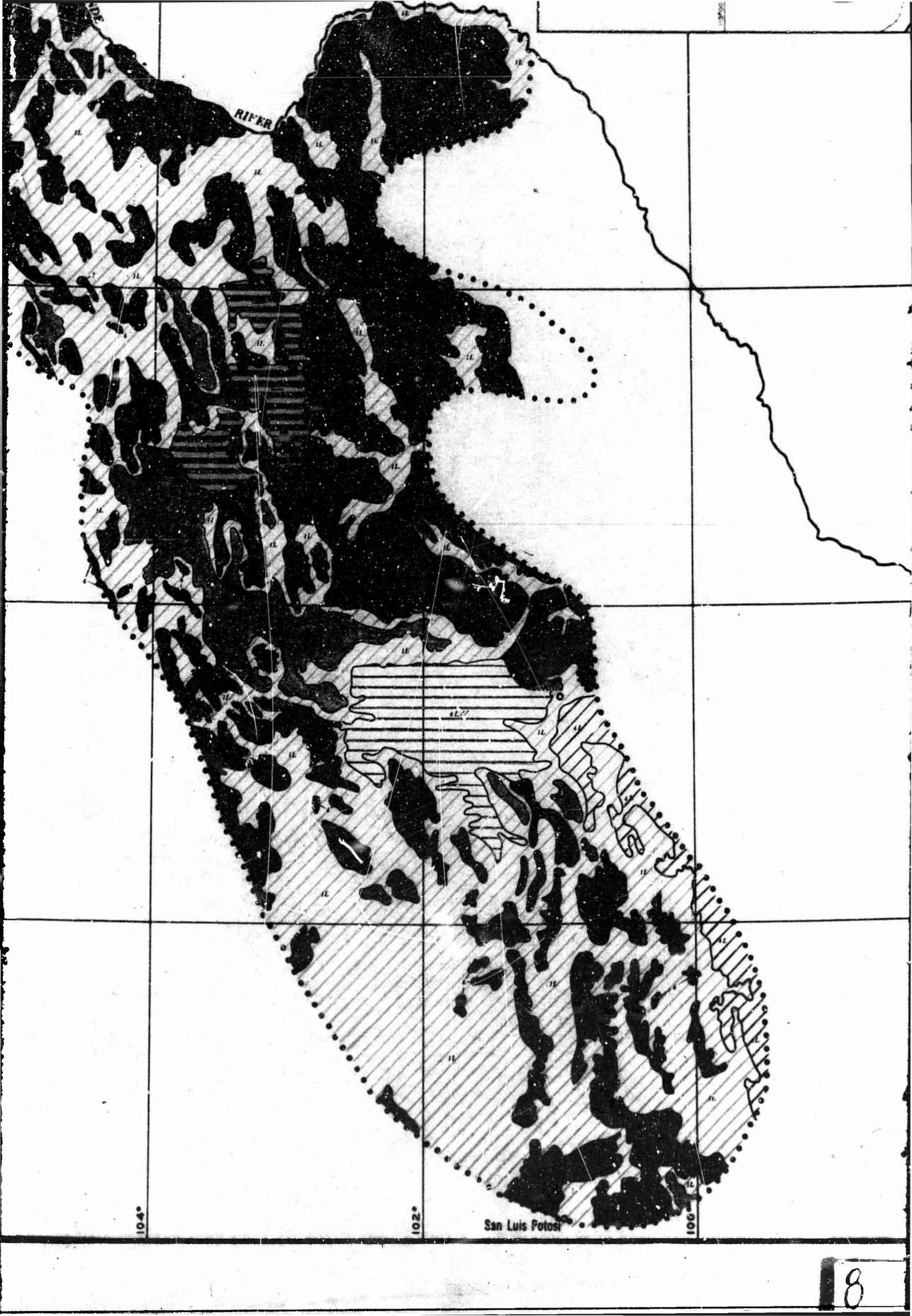
1 / 7 — Gross plan-profile / Plan-profile of component highs



* Highs are considered to be (1) peaked or crested prominences which exhibit characteristic slopes greater than 6 degrees or (2) fairly flat-topped prominences or high-level areas bounded by slopes in excess of 14 degrees.


Tiburon
Cedros
Carmen
Santa Margarita
P A C I F I C O C E A N
C A L I F
28°
26°
24°
22°
118°
114°
112°


Hermosillo
Carmen
Santa Catallina
San Jose
Espiritu Santo
SCALE
50 0 50 100 MI.
110°
108°
106°


RIVER
104°
102°
100°
San Luis Potosí

CHARACTERISTIC PLAN-PROFILE

The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either gross or restrictive. A gross plan-profile is one that can be subdivided into two restrictive component plan-profiles each exhibiting relief of a lower order than the gross plan-profile. Random sampling with circles 15 miles in diameter is used in determining the gross profile. Random sampling with circles 1 mile in diameter is used to determine the restrictive p profile. Local relief of less than 10 feet is not considered.

LEGEND

Highs* Occupy:	Highs are → Schematic Plan / Schematic Profile	Non-linear and Random	Linear and Random	Non-linear and Parallel	Linear and Parallel
>60% of area	Flat-topped	1	1L**	1// ***	1L //
40-60% of area	Flat-topped	2	2L	2 //	2L //
<40% of area	Flat-topped	3	3L	3 //	3L //
>60% of area	Crested or Peaked	4	4L	4 //	4L //
40-60% of area	Crested or Peaked	5	5L	5 //	5L //
<40% of area	Crested or Peaked	6	6L	6 //	6L //
No pronounced highs or lows		7			

PLAN-PROFILE COMPLEXES:

Areal Complexes: Mapped in areas where two major, areally restricted, plan-profile occur.

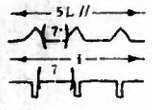
1/2 — Areally predominant plan-profile of the lows; Areally subordinate plan-profile of the highs

1\4 — Areally predominant plan-profile of the highs; Areally predominant plan-profile of the lows

Gross-component Complexes: Confined to areas where a gross and a component plan-profile are mapped.

5L // / 7 — Gross plan-profile; Plan-profile of component lows

1 | 7 — Gross plan-profile; Plan-profile of component highs



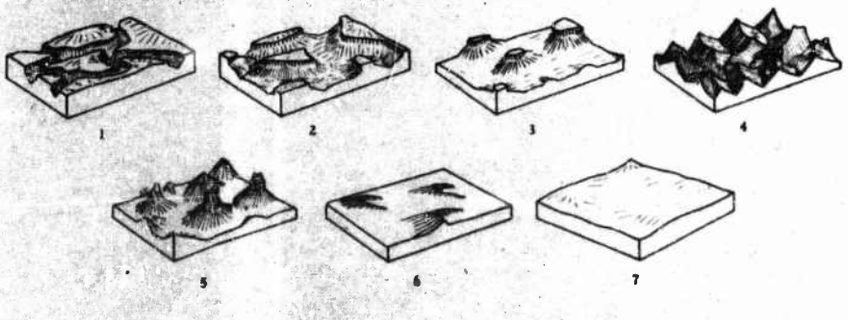
e Highs are considered to be (1) peaked or crested prominences which exhibit characteristic slopes greater than 6 degrees or (2) fairly flat-topped prominences or high-level areas bounded by slopes in excess of 14 degrees.

** L indicates linearity of highs. A high is considered to be linear when its length is greater than 5 times its width.

*** // indicates roughly parallel arrangement of highs or aligned highs.

REPRESENTATIVE PLAN-PROFILES

Each of the following block diagrams illustrates a landscape representative of a specific plan-profile type. It should be emphasized that, within the defined limits of each type, a wide variety of landscape configurations are possible.

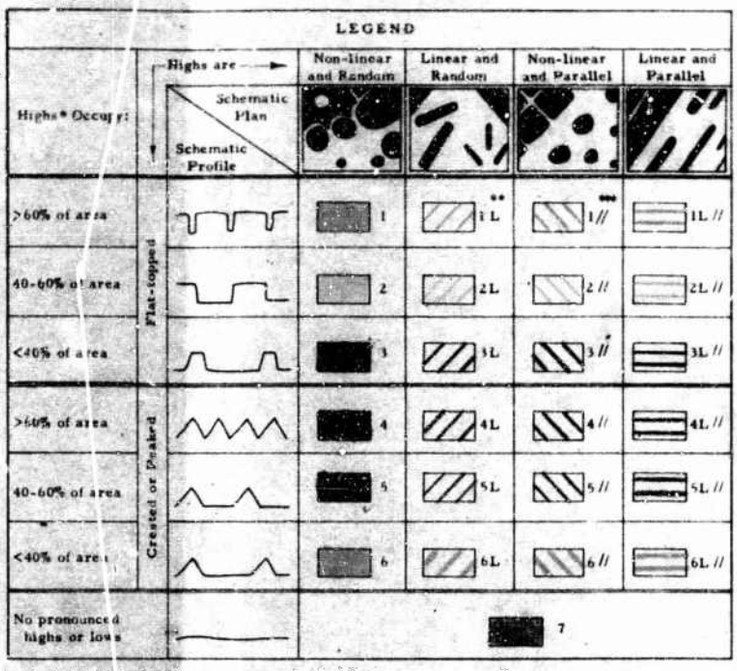


ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

CHARACTERISTIC PLAN-PRO

CHARACTERISTIC PLAN-PROFILE

The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either gross or restrictive. A gross plan-profile is one that can be subdivided into two restrictive component plan-profiles each exhibiting relief of a lower order than the gross plan-profile. Random sampling with circles 35 miles in diameter is used in determining the gross profile. Random sampling with circles 1 mile in diameter is used to determine the restrictive plan-profile. Local relief of less than 10 feet is not considered.



PLAN-PROFILE COMPLEXES:

Areal Complexes: Mapped in areas where two major, areally restricted, plan-profile occur.

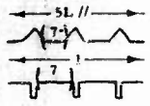
1/4 — Areally predominant plan-profile of the lows
Areally subordinate plan-profile of the highs

1/4 — Areally predominant plan-profile of the highs
Areally predominant plan-profile of the lows

Gross-component Complexes: Confined to areas where a gross and a component plan-profile are mapped.

5L // / 7 — Gross plan-profile
Plan-profile of component lows

1 / 7 — Gross plan-profile
Plan-profile of component highs



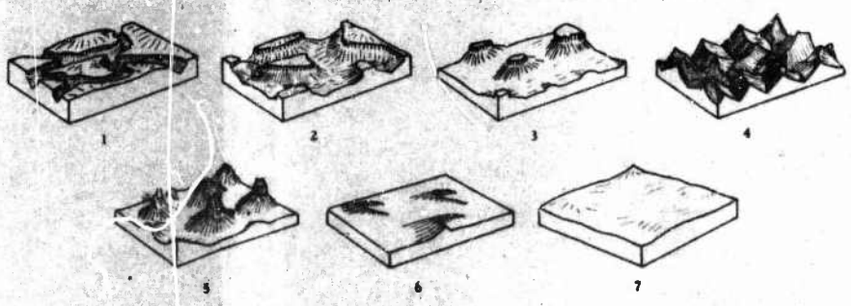
* Highs are considered to be (1) peaked or crested prominences which exhibit characteristic slopes greater than 6 degrees or (2) fairly flat-topped prominences or high-level areas bounded by slopes in excess of 14 degrees.

** L indicates linearity of highs. A high is considered to be linear when its length is greater than 5 times its width.

*** // indicates roughly parallel arrangement of highs or aligned highs.

REPRESENTATIVE PLAN-PROFILES

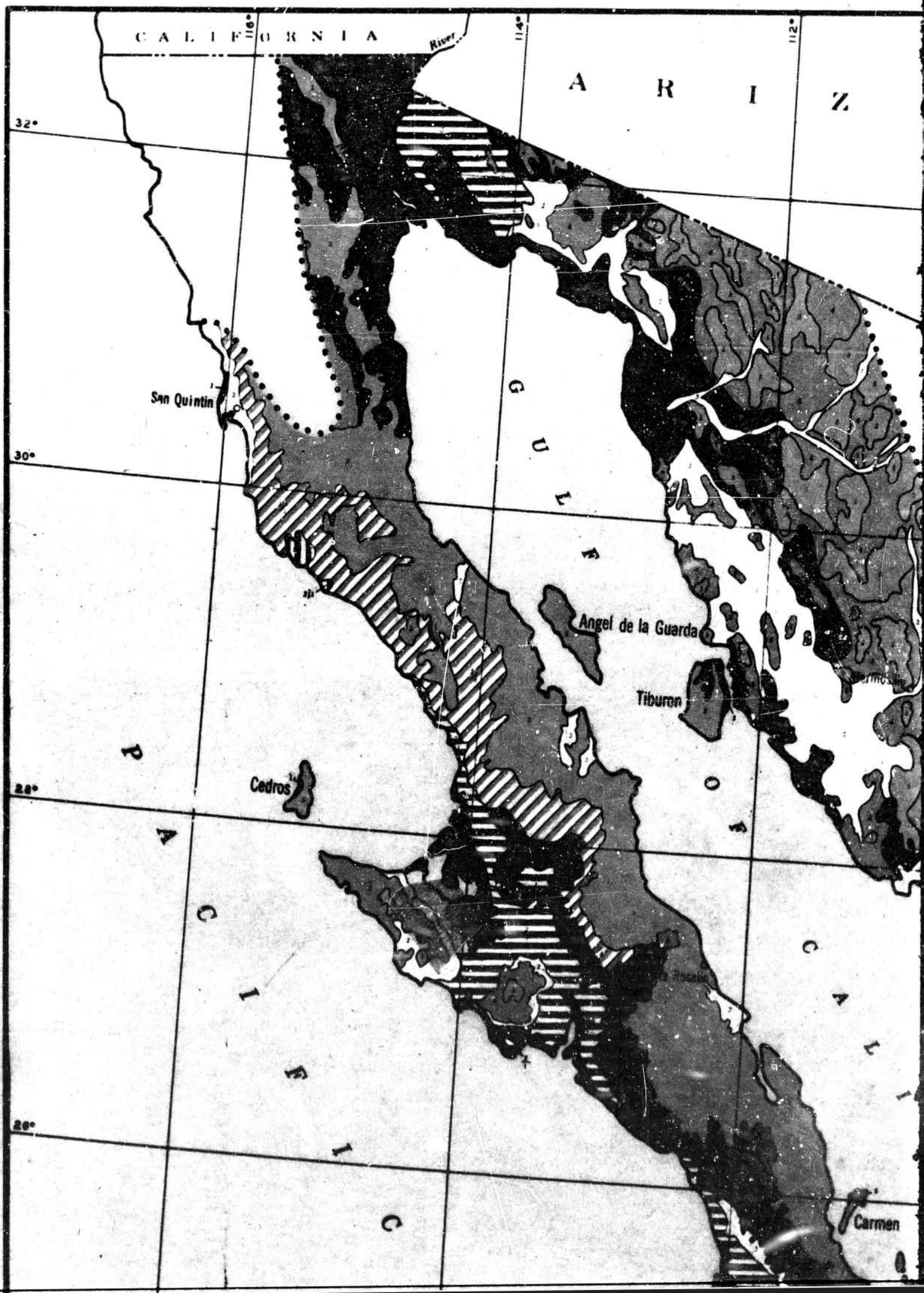
Each of the following block diagrams illustrates a landscape representative of a specific plan-profile type. It should be emphasized that, within the defined limits of each type, a wide variety of landscape configurations are possible.

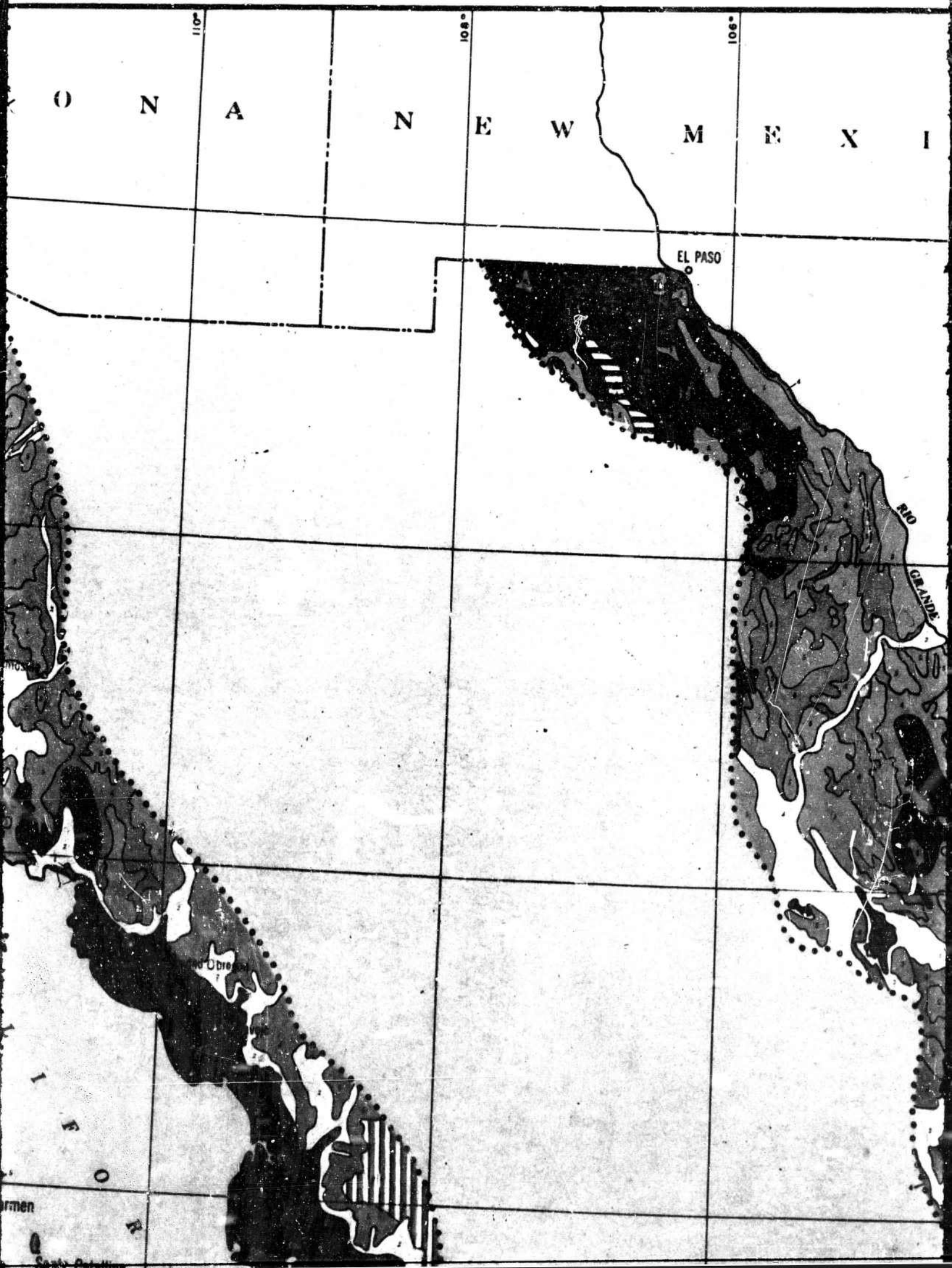


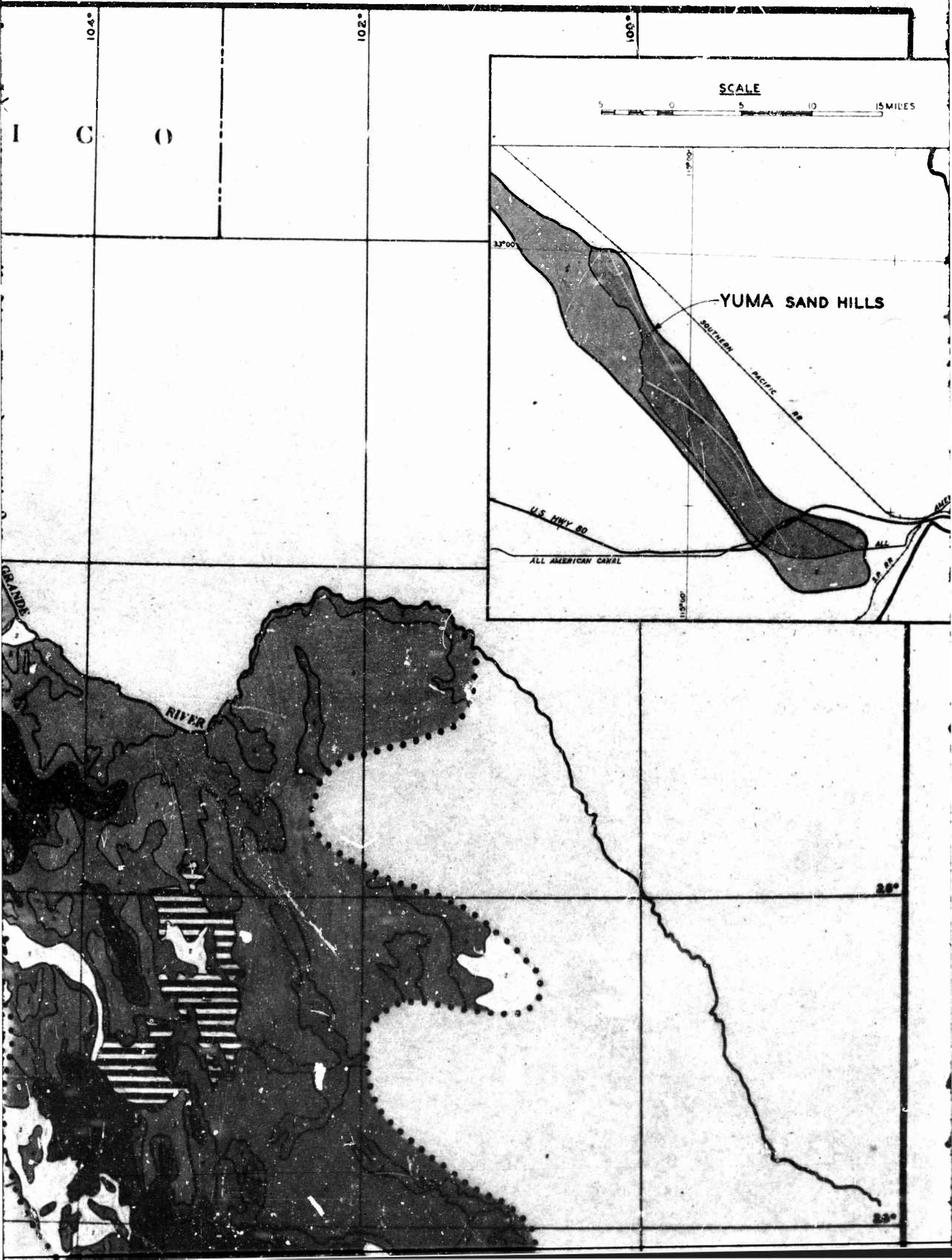
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

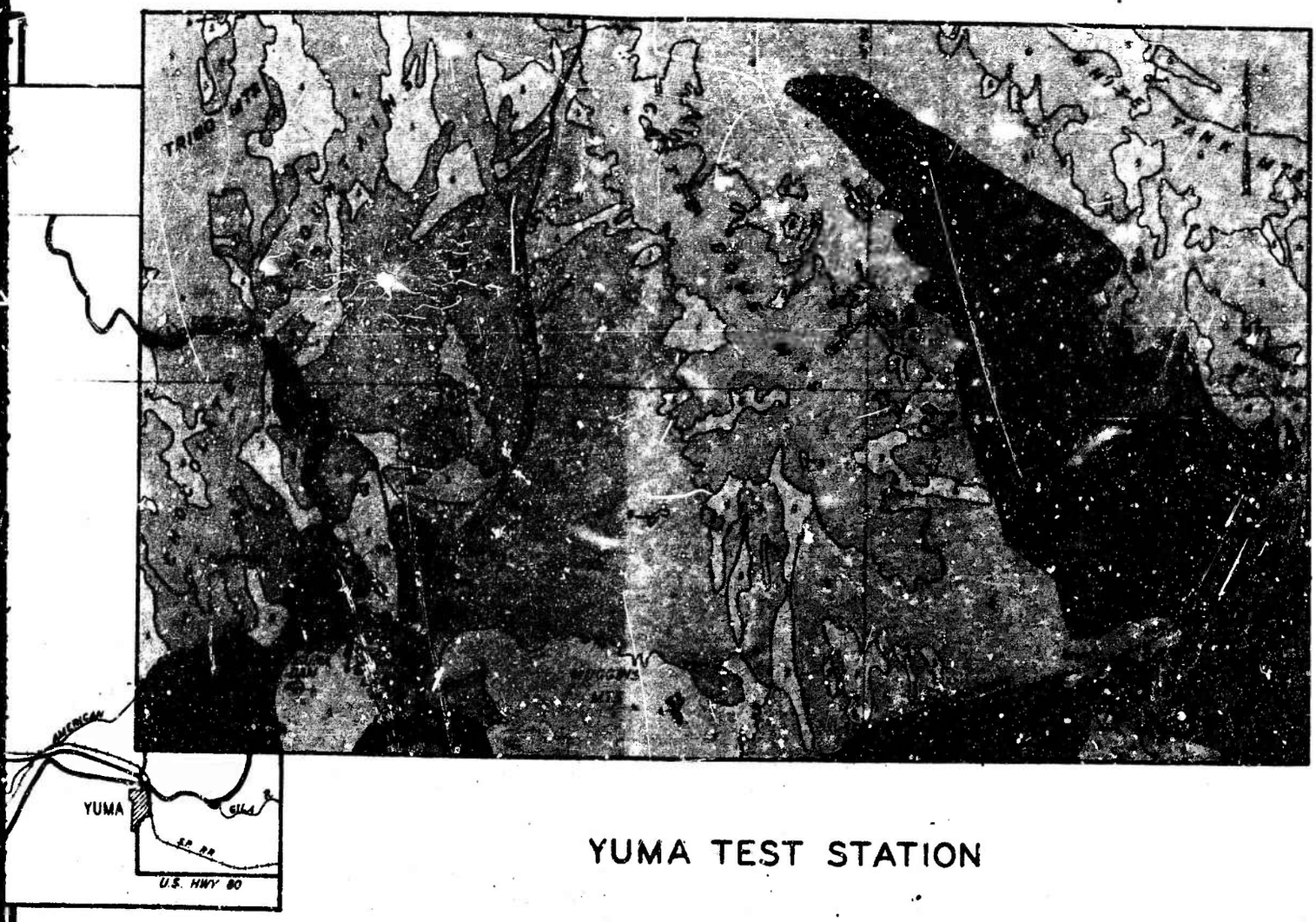
CHARACTERISTIC PLAN-PROFILE

10


CALIFORNIA
River
ARIZ
32°
30°
28°
26°
116°
114°
112°
San Quintin
GULF OF CALIFORNIA
Angel de la Guarda
Tiburon
Cedros
PACIFIC
Carmen


110°
106°
106°
O N A
N E W M E X I
EL PASO
RIO GRANDE


104°
102°
100°
I C O
SCALE
5 0 5 10 15 MILES
33°00'
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
GRANDE
RIVER
26°
23°



YUMA TEST STATION

OCCURRENCE OF SLOPES GREATER THAN 50 PER CENT

Frequency of occurrence is determined in a direction containing the maximum number of slopes steeper than 50 per cent. Minimum relief considered is 10 feet.

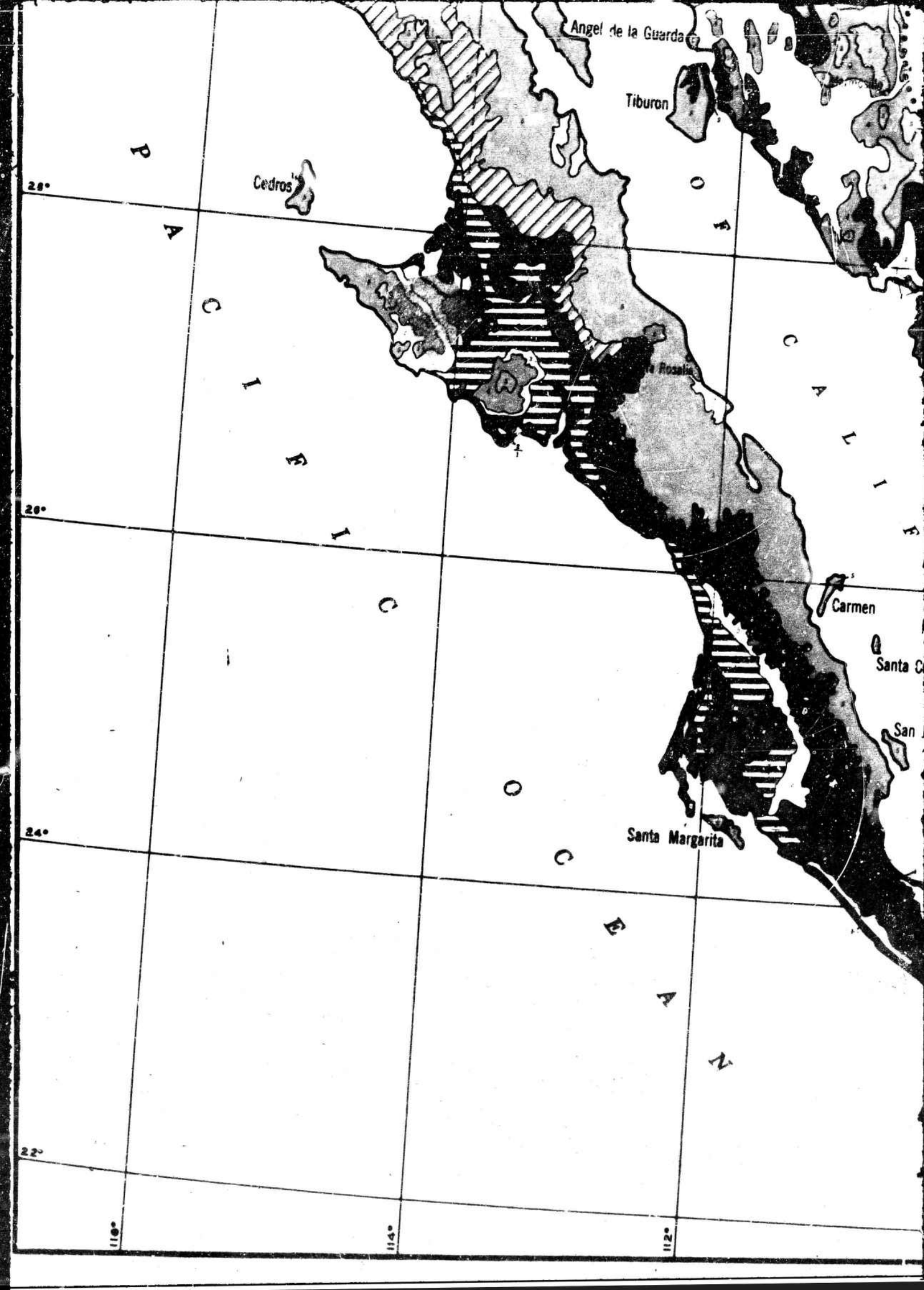
1. The number of slopes steeper than 50 per cent is less than 1 per 10 miles or in areas, less than 10 miles in maximum dimension, wherein such slopes are lacking.
2. The number of slopes steeper than 50 per cent ranges from 1 to 5 per 10 miles.
3. The number of slopes steeper than 50 per cent ranges from 5 to 20 per 10 miles.
4. The number of slopes steeper than 50 per cent ranges from 20 to 100 per 10 miles.
5. The number of slopes steeper than 50 per cent ranges from 100 to 200 per 10 miles.
6. The number of slopes steeper than 50 per cent exceeds 200 per 10 miles.

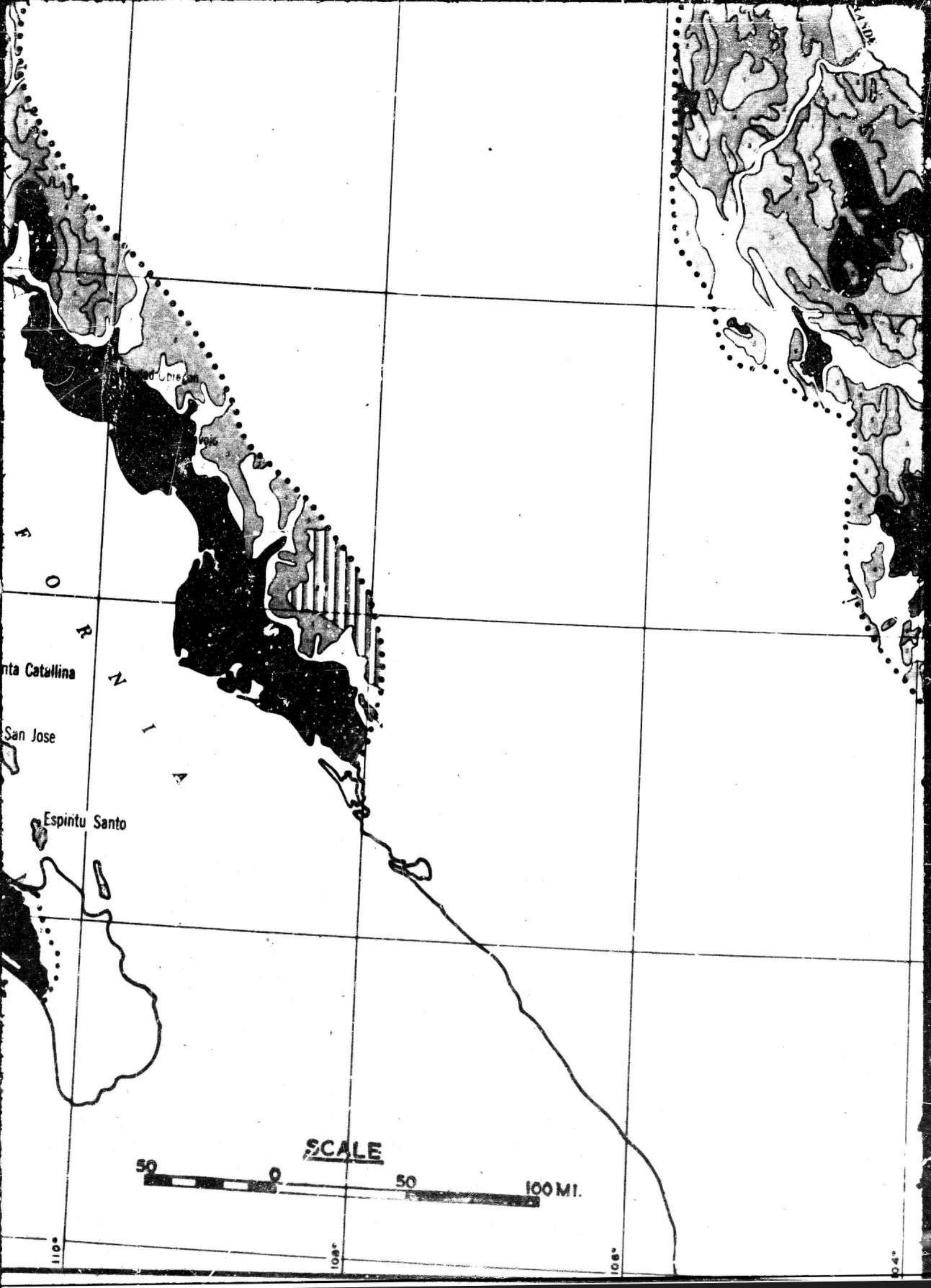
OCCURRENCE COMPLEXES:

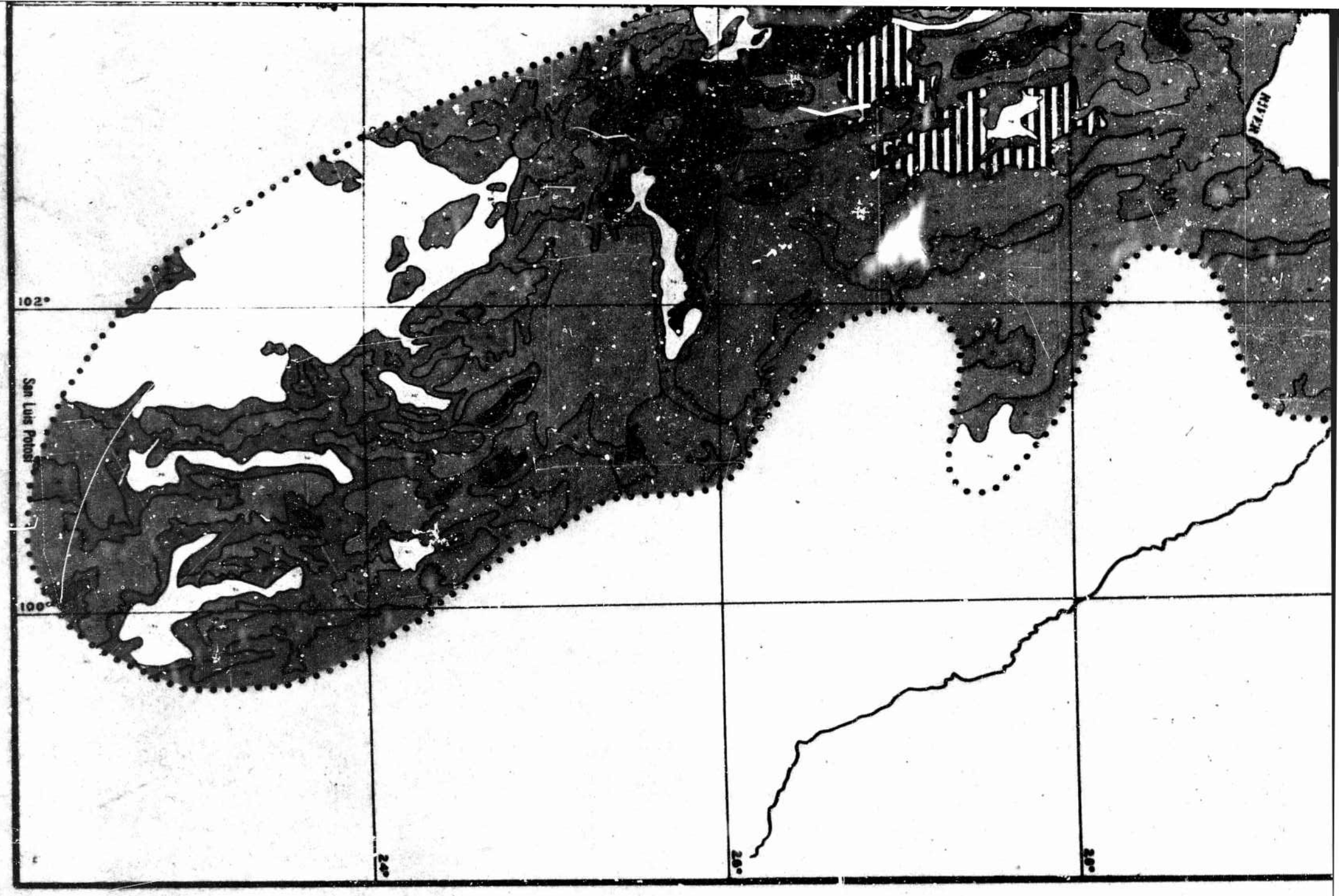
Areal Complexes: Mapped in areas where two dominant slope occurrence types are found.

- Areally predominant slope occurrence.
  Areally subordinate slope occurrence within highs.
- Areally predominant slope occurrence.
  Areally subordinate slope occurrence within lows.

Gross-component Complexes: Confined to areas where a gross plan-profile


Angel de la Guarda
Tiburon
Cedros
Carmen
Santa Margarita
28°
26°
24°
22°
110°
114°
112°


F O R N I A
nta Catallina
San Jose
Espintu Santo
SCALE
50
0
50
100 MI.
110°
108°
106°
104°


102°
San Luis Potosí
100°
24°
25°
25°

OCCURRENCE OF SLOPES GREATER THAN 50 PER CENT

Frequency of occurrence is determined in a direction containing the maximum number of slopes steeper than 50 per cent. Minimum relief considered is 10 feet.

1  The number of slopes steeper than 50 per cent is less than 1 per 10 miles or in areas, less than 10 miles in maximum dimension, wherein such slopes are lacking.

2  The number of slopes steeper than 50 per cent ranges from 1 to 5 per 10 miles.

3  The number of slopes steeper than 50 per cent ranges from 5 to 20 per 10 miles.

4  The number of slopes steeper than 50 per cent ranges from 20 to 100 per 10 miles.

5  The number of slopes steeper than 50 per cent ranges from 100 to 200 per 10 miles.

6  The number of slopes steeper than 50 per cent exceeds 200 per 10 miles.

OCCURRENCE COMPLEXES:

Areal Complexes: Mapped in areas where two dominant slope occurrence types are found.


Areally predominant slope occurrence.
Areally subordinate slope occurrence within highs.


Areally predominant slope occurrence.
Areally subordinate slope occurrence within lows.

Gross-component Complexes: Confined to areas where a gross plan-profile and a portion or component part of this plan-profile are mapped.


Occurrence of gross highs.
Slope occurrence within component lows.


Occurrence of gross lows.
Slope occurrence within component highs.

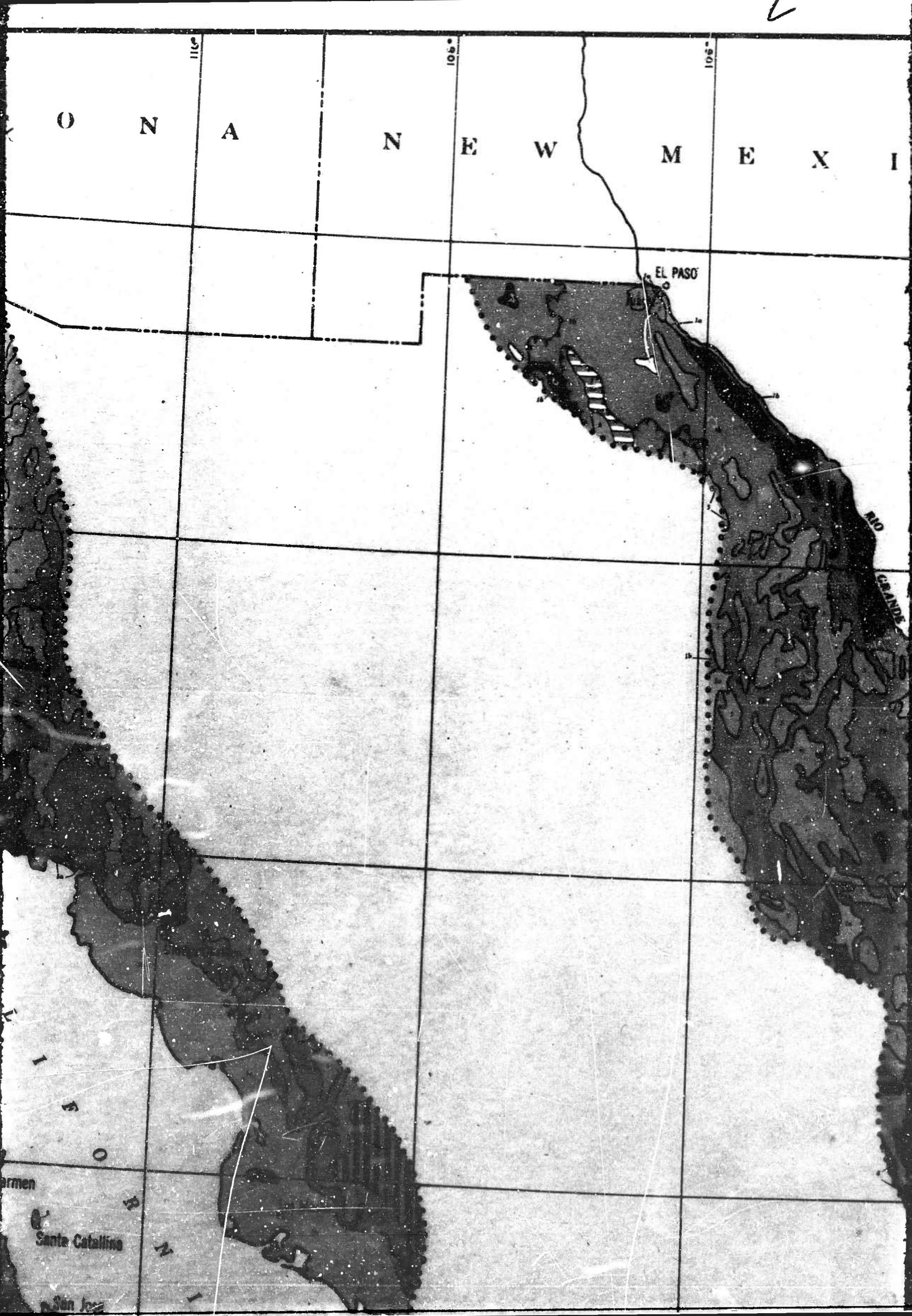
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

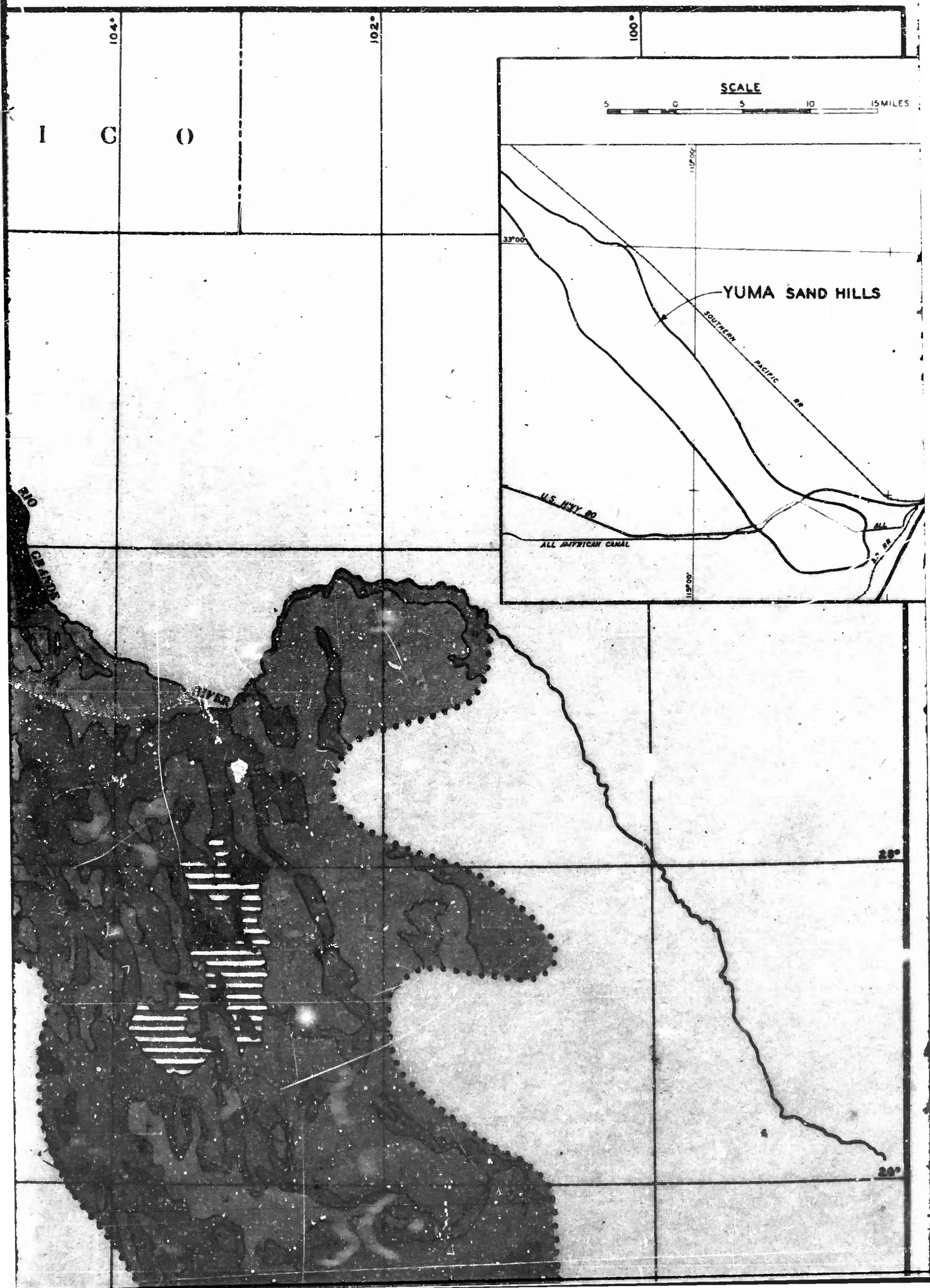
SLOPE OCCURRENCE

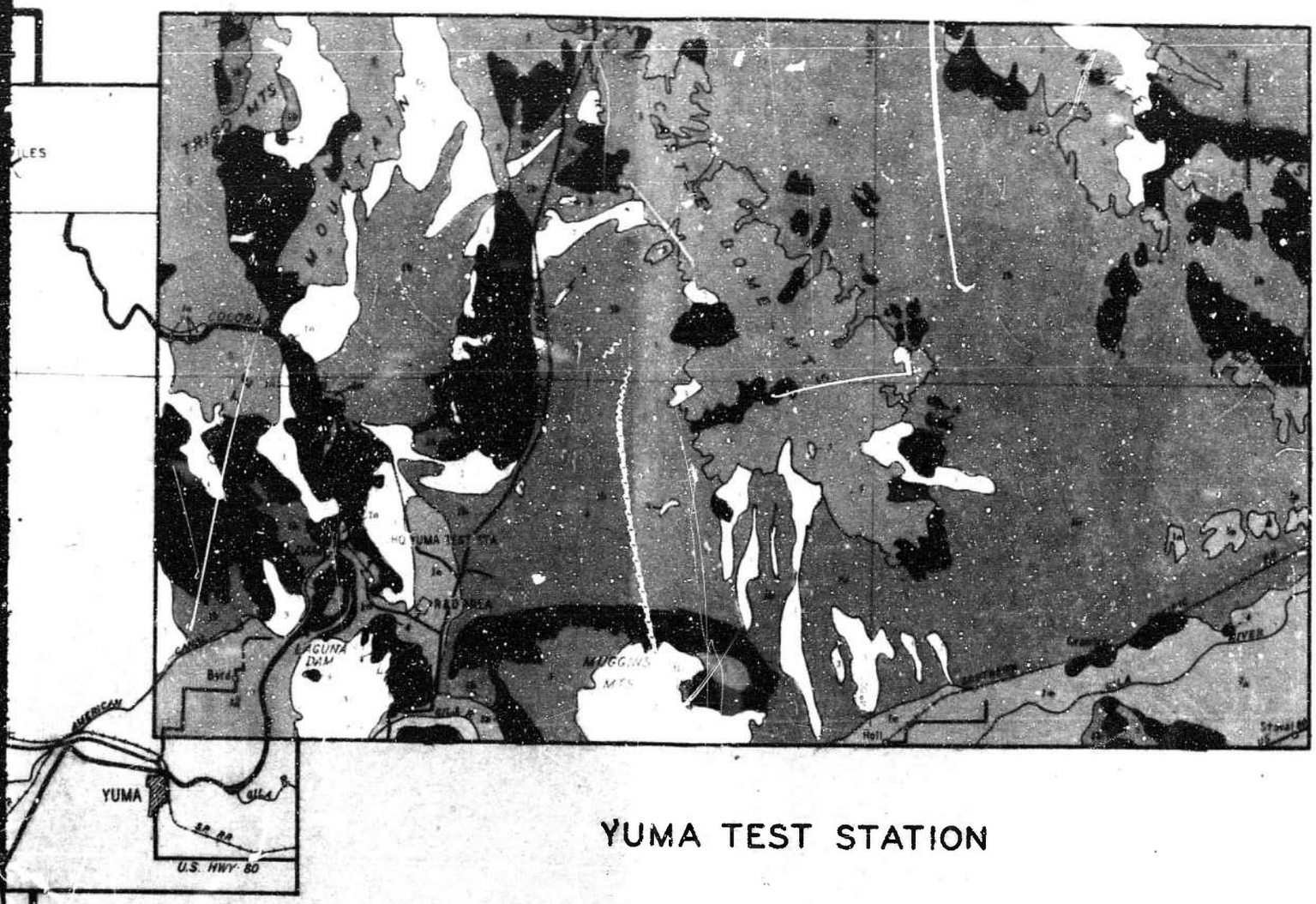
8

PLATE 2


CALIFORNIA
River
ARIZ
116°
114°
112°
32°
30°
28°
26°
San Quintin
GULF
Angel de la Guarda
Tiburon
Cedros
PACIFIC
CALI
Carmen


O N A
N E W M E X I
EL PASO
RIO GRANDE
Santa Catalina
San Jose


104°
102°
100°
I C O
SCALE
5 0 5 10 15 MILES
115°00'
33°00'
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
ALL
RR
115°00'
RIO GRANDE
RIVER
28°
28°



YUMA TEST STATION

CHARACTERISTIC SLOPES

Slope is defined as a surface identified or designated in terms of its deviation from the horizontal. The amount of deviation is commonly expressed as a rate of vertical rise per horizontal interval, as a percentage, or in degrees.

Flat: Characteristic slope between 0 and 2 degrees (approx. 0 - 3.5%).

1a — Between 0 and 1/2 degree (approx. 0 - 1%).

1b — Between 1/2 and 2 degrees (approx. 1 - 3.5%).

2 — **Gentle:** Characteristic slope between 2 and 6 degrees (approx. 3.5 - 10%).

3 — **Moderate:** Characteristic slope between 6 and 14 degrees (approx. 10 - 25%).

4 — **Declivitous:** Characteristic slope between 14 and 26.5 degrees (approx. 25 - 50%).

5 — **Steep:** Characteristic slope between 26.5 and 45 degrees (approx. 50 - 100%).

6 — **Precipitous:** Characteristic slope greater than 45 degrees (greater than 100%).

SLOPE COMPLEXES:

Areal Complexes: Mapped in areas where two dominant slopes occur.

Areally predominant characteristic slope.
Areally subordinate characteristic slope within highs.

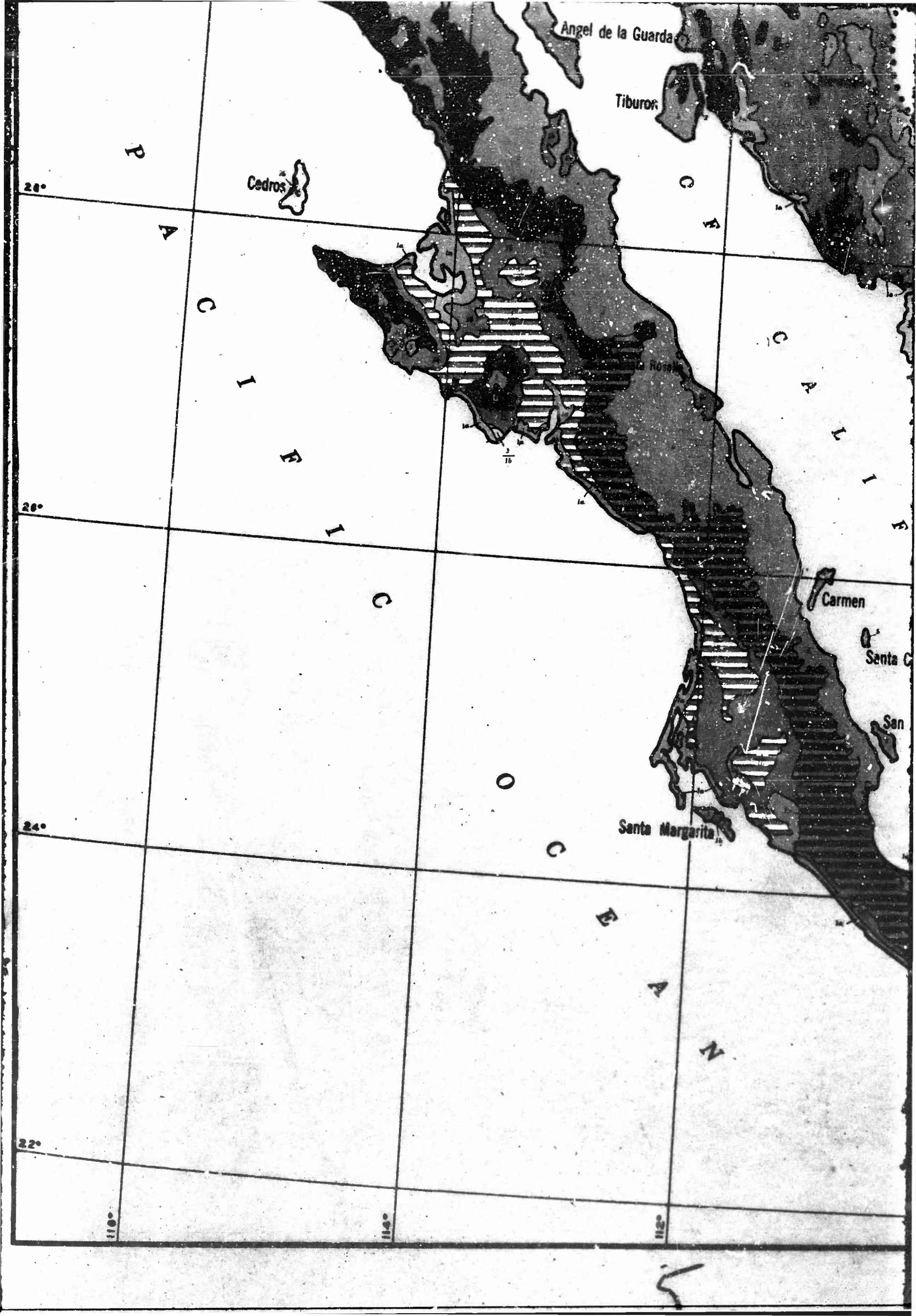
Areally predominant characteristic slope.
Areally subordinate characteristic slope within lows.

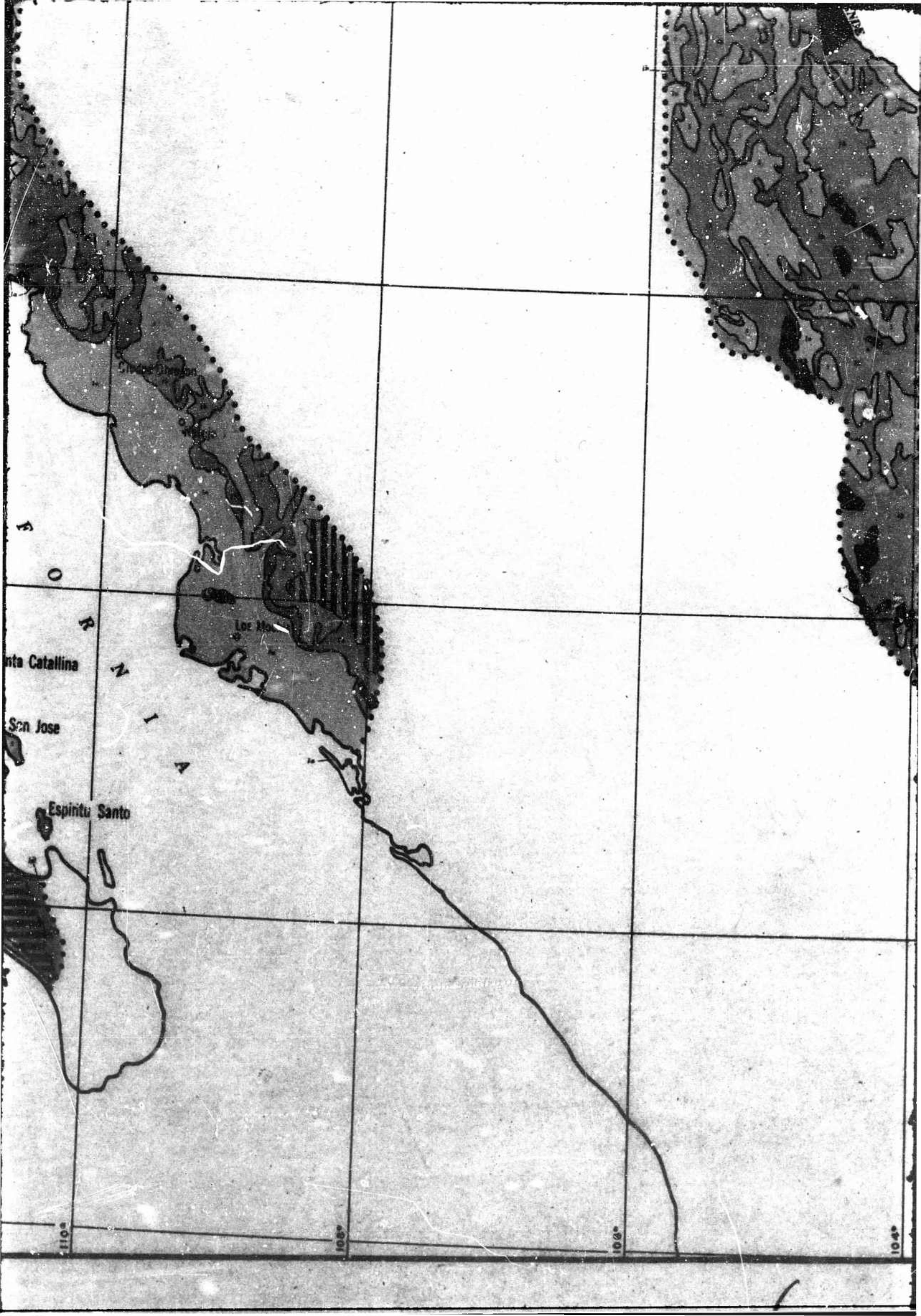
Gross-component Complexes: Confined to areas where a gross plan-profile and a portion or component part of this plan-profile are mapped.

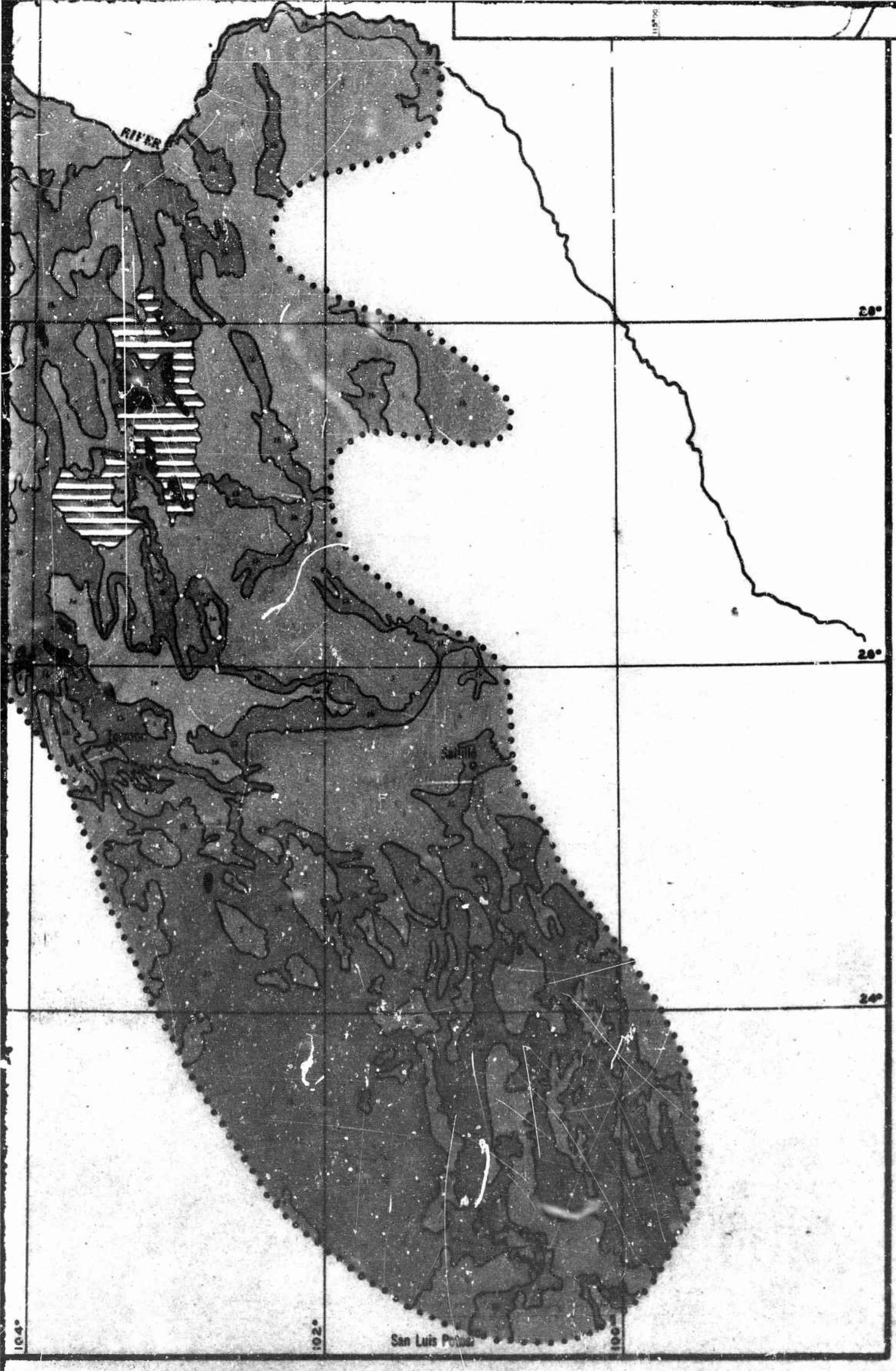
Characteristic slope of gross highs.
Characteristic slope of component lows.

Characteristic slope of gross lows.
Characteristic slope of component highs.

Important Scarps: An important scarp is defined as a more or less continuous precipitous slope exhibiting more than 100 feet of relief. Only the better known scarps which extend for considerable distances have been mapped. Scarp height is indicated where known.


Angel de la Guarda
Tiburon
Cedros
P A C I F I C O
C E A N O
C A L I F
Carmen
Santa C
San
Santa Margarita
28°
26°
24°
22°
116°
114°
112°


F O R N I A
nta Catallina
San Jose
Espiritu Santo
110°
108°
106°
104°


RIVER
28°
26°
24°
104°
102°
100°
San Luis Potosí

U.S. HWY 80

CHARACTERISTIC SLOPE*

Slope is defined as a surface identified or designated in terms of its deviation from the horizontal. The amount of deviation is commonly expressed as a rate of vertical rise per horizontal interval, as a percentage, or in degrees.

Flat: Characteristic slope between 0 and 2 degrees (approx. 0 - 3.5%).

1a — Between 0 and 1/2 degree (approx. 0 - 1%).

1b — Between 1/2 and 2 degrees (approx. 1 - 3.5%).

2 — **Gentle:** Characteristic slope between 2 and 6 degrees (approx. 3.5 - 10%).

3 — **Moderate:** Characteristic slope between 6 and 14 degrees (approx. 10 - 25%).

4 — **Declivitous:** Characteristic slope between 14 and 26.5 degrees (approx. 25 - 50%).

5 — **Steep:** Characteristic slope between 26.5 and 45 degrees (approx. 50 - 100%).

6 — **Precipitous:** Characteristic slope greater than 45 degrees (greater than 100%).

SLOPE COMPLEXES:

Areal Complexes: Mapped in areas where two dominant slopes occur.

Areally predominant characteristic slope.
Areally subordinate characteristic slope within highs.

Areally predominant characteristic slope.
Areally subordinate characteristic slope within lows.

Gross-component Complexes: Confined to areas where a gross plan-profile and a portion or component part of this plan-profile are mapped.

Characteristic slope of gross highs.
Characteristic slope of component lows.

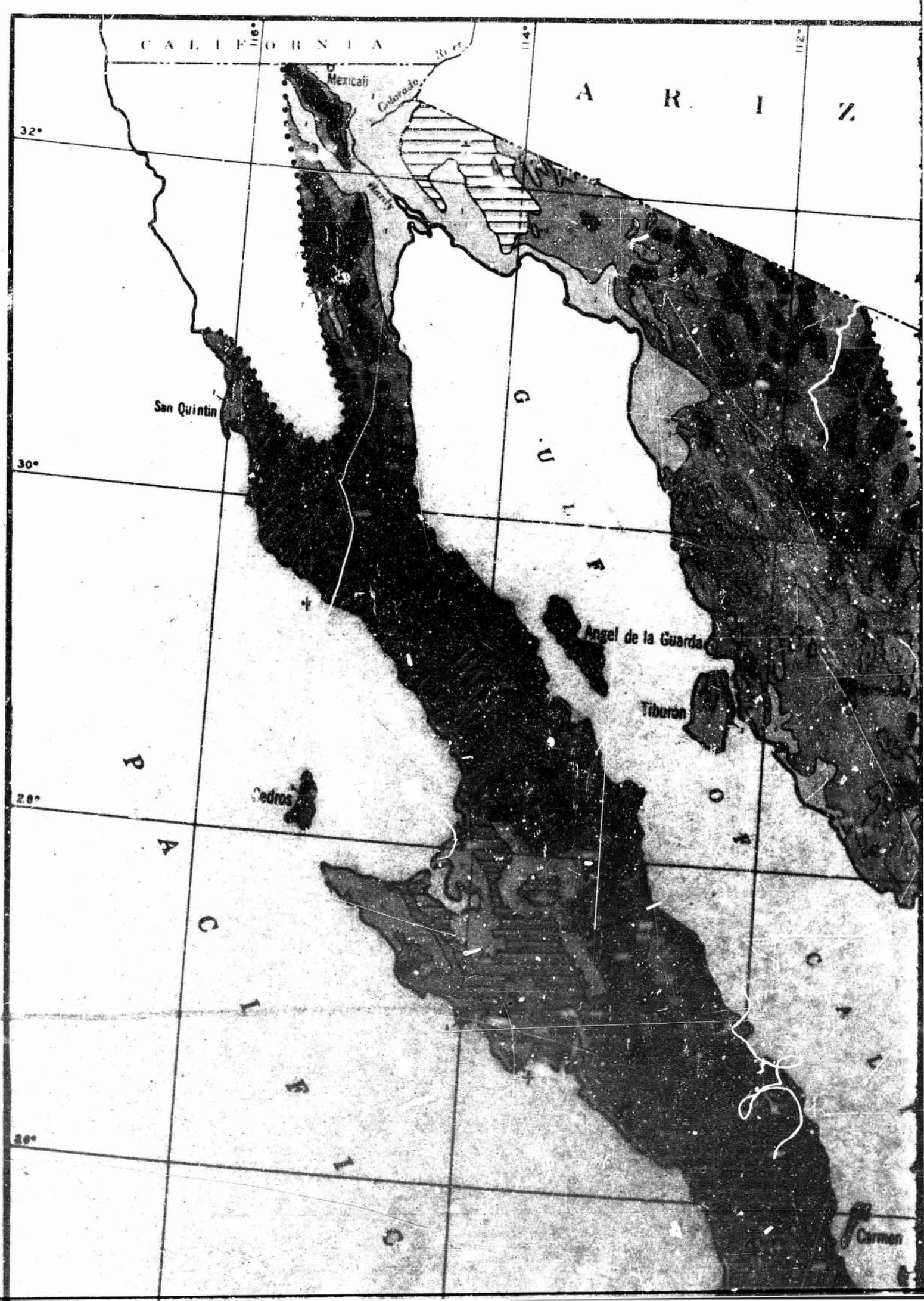
Characteristic slope of gross lows.
Characteristic slope of component highs.

Important Scarps: An important scarp is defined as a more or less continuous precipitous slope exhibiting more than 100 feet of relief. Only the better known scarps which extend for considerable distances have been mapped.* Scarp height is indicated where known.

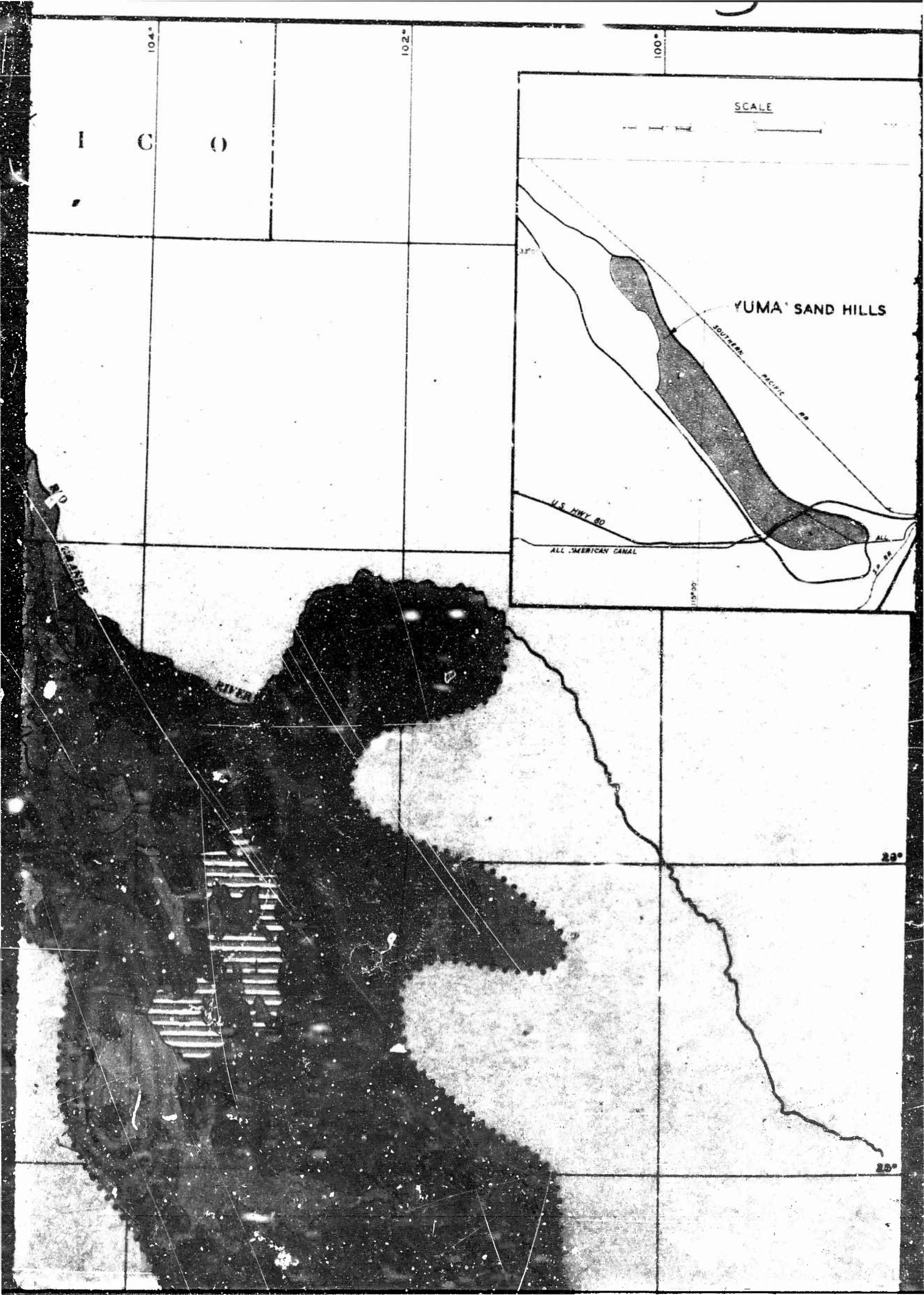
* Characteristic slope is defined as a narrow range of slopes which predominates or is most common within a region (possessing a distinctive spacing, arrangement, or pattern of contour lines) mapped with a 10-foot contour interval.

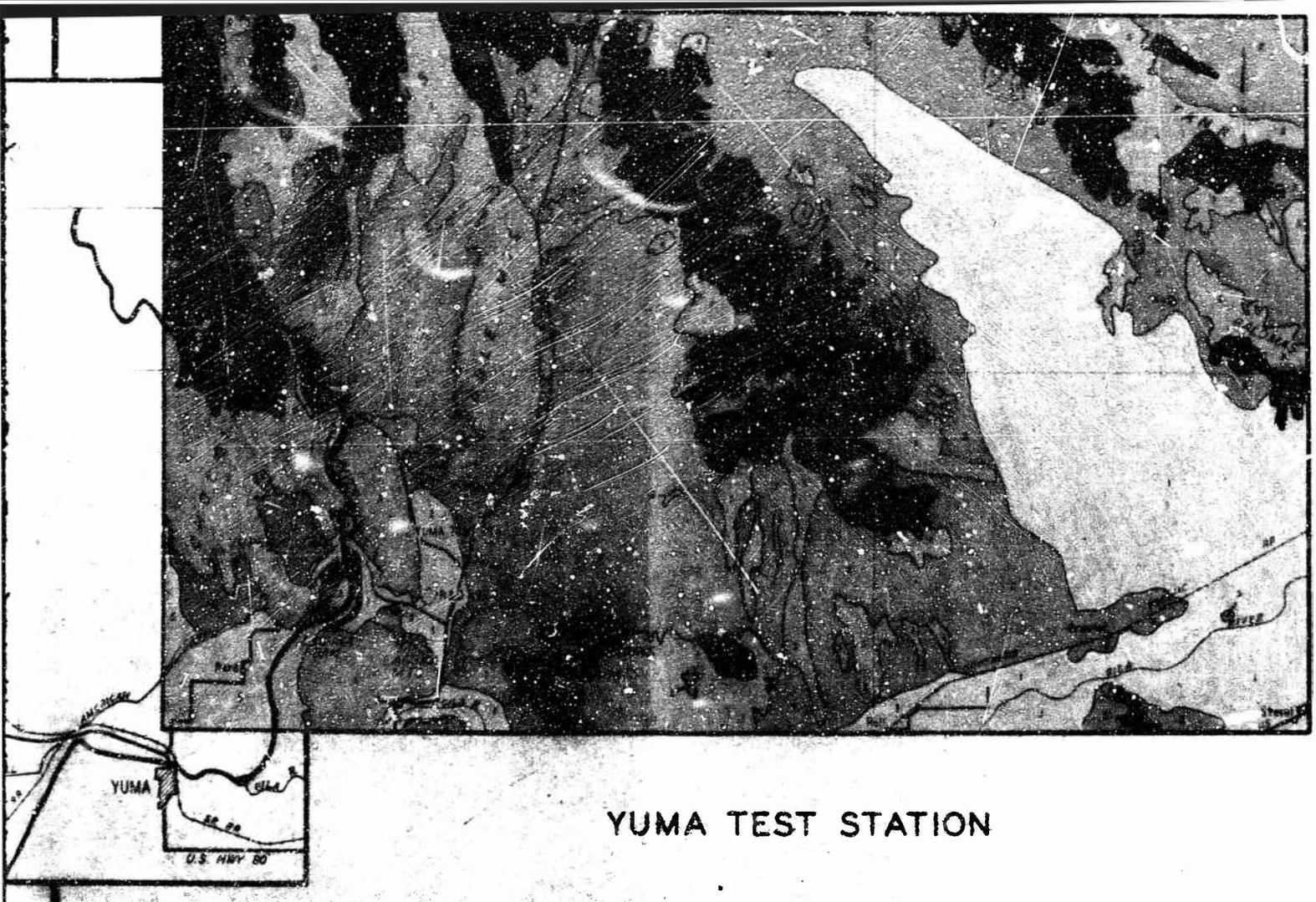
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

CHARACTERISTIC SLOPE


CALIFORNIA
Mexicali
Colorado River
ARIZ
32°
San Quintin
30°
GULF OF CALIFORNIA
Angel de la Guarda
Tiburon
Pedros
28°
PACIFIC OCEAN
26°
Carmen


110°
108°
106°
O N A
N E W M E X
EL PASO
RIO


104°
102°
100°
I C O
SCALE
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
RIO GRANDE
RIVER
29°
28°



YUMA TEST STATION

CHARACTERISTIC RELIEF

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the vertical distance from interfluve crest to the immediately adjacent flow line —

1 Characteristic relief between 0 and 10 feet.

2 Characteristic relief between 10 and 50 feet.

3 Characteristic relief between 50 and 100 feet.

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the maximum difference in elevation per square mile, or in areas where drainage lines are poorly developed or lacking,* from summit to adjacent low —

* Usually restricted to sand dune areas—maximum height of dunes indicated where known.

4 Characteristic relief between 0 and 50 feet.

5 Characteristic relief between 50 and 400 feet.

6 Characteristic relief between 400 and 1,000 feet.

7 Characteristic relief greater than 1,000 feet.

RELIEF COMPLEXES:

Areal Complexes: Mapped in areas where two dominant relief types occur.

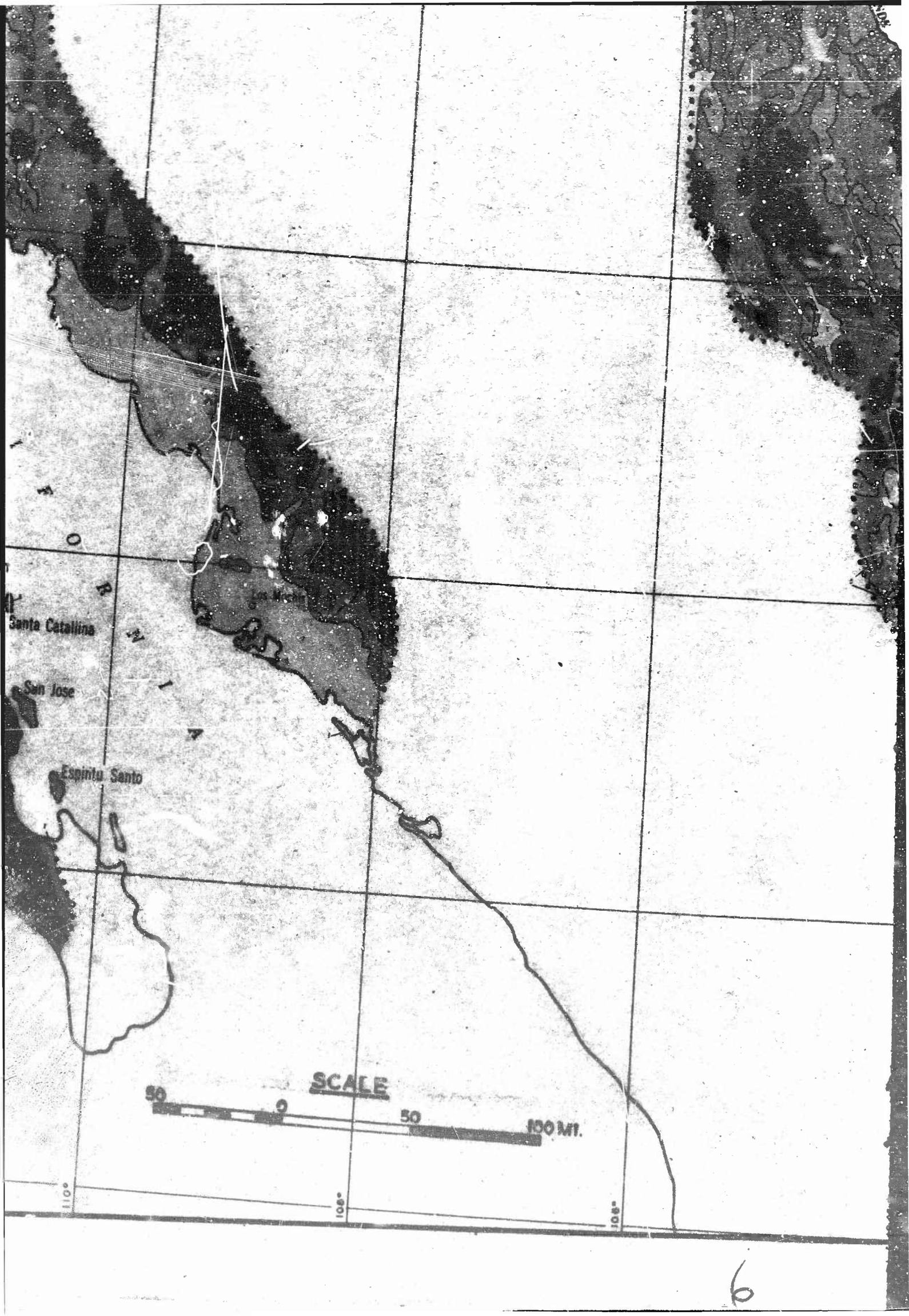
Areally predominant relief type.
Areally subordinate relief type within highs.

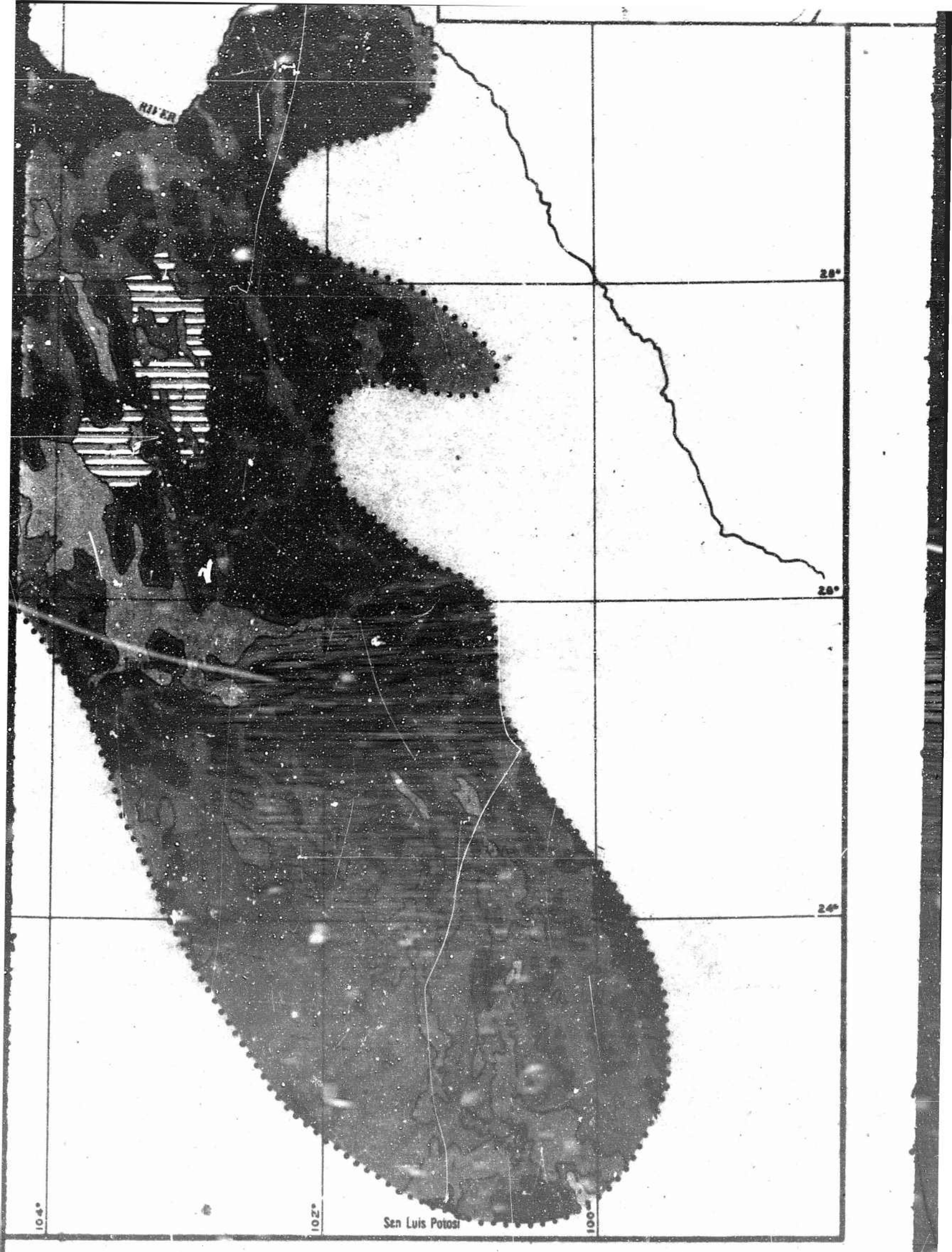
Areally predominant relief type.
Areally subordinate relief type within lows.

Gross-component Complexes: Confined to areas where a gross plan-profile and a portion or components part of this plan-profile are mapped.

Relief of gross highs.
Relief within component lows.


Tiburon
Cedros
Carmen
Santa Margarita
PACIFICO
OCEANO
CALIFORNIA
28°
26°
24°
22°
116°
114°
112°


Santa Catalina
San Jose
Espiritu Santo
SCALE
50
0
50
100 Mi.
110°
108°
106°


RIVER
28°
28°
24°
104°
102°
100°
San Luis Potosi

U.S. HWY 80

CHARACTERISTIC RELIEF

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the vertical distance from interfluve crest to the immediately adjacent flow line —

1 Characteristic relief between 0 and 10 feet.

2 Characteristic relief between 10 and 50 feet.

3 Characteristic relief between 50 and 100 feet.

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the maximum difference in elevation per square mile, or in areas where drainage lines are poorly developed or lacking,[e] from summit to adjacent low —

[e] Usually restricted to sand dune areas—maximum height of dunes indicated where known.

4 Characteristic relief between 0 and 50 feet.

5 Characteristic relief between 50 and 400 feet.

6 Characteristic relief between 400 and 1,000 feet.

7 Characteristic relief greater than 1,000 feet.

RELIEF COMPLEXES:

Areal Complexes: Mapped in areas where two dominant relief types occur.

Areally predominant relief type.
Areally subordinate relief type within highs.

Areally predominant relief type.
Areally subordinate relief type within lows.

Gross-component Complexes: Confined to areas where a gross plan-profile and a portion or component part of this plan-profile are mapped.

Height of gross highs.
Relief within component lows.

Depth of gross lows.
Relief within component highs.

Important Scarps: A scarp is defined as a more or less-continuous precipitous slope exhibiting more than 100 feet of relief. Only the better known scarps which extend for considerable distances have been mapped. Scarp height is indicated where known.

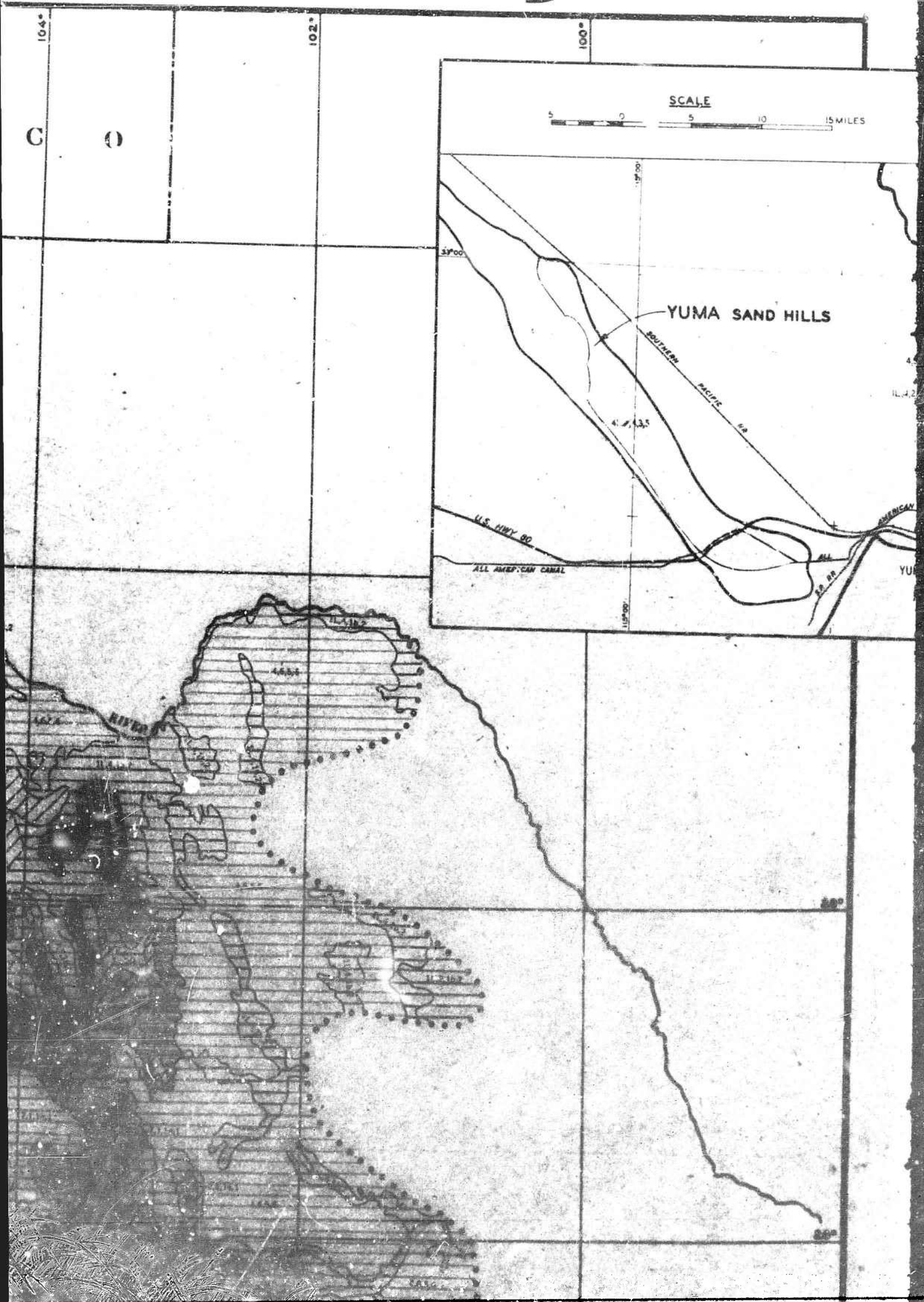
ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

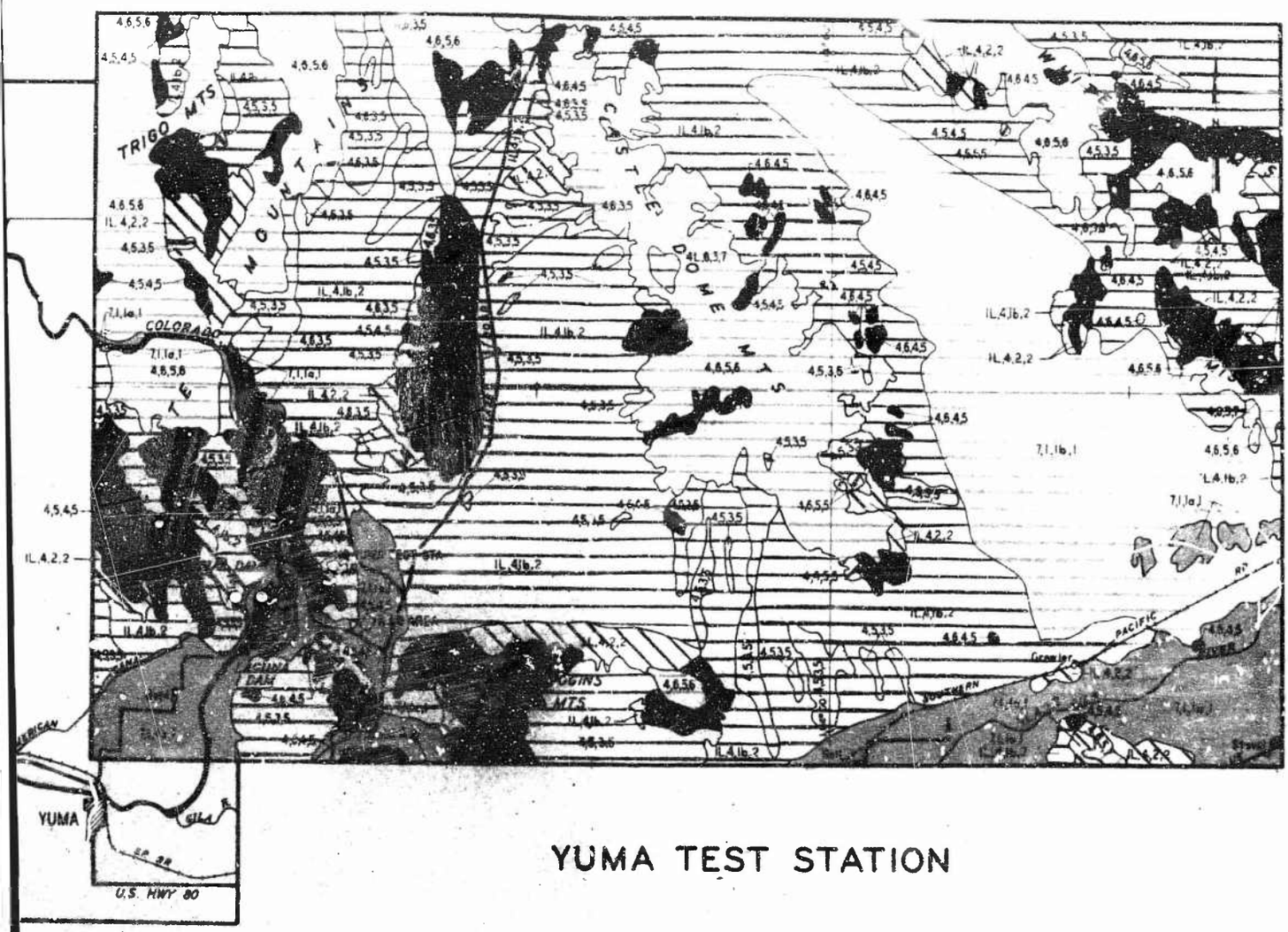
CHARACTERISTIC RELIEF

PLATE 4


CALIFORNIA
ARIZ
GULF
PACIFIC
Mexicali
Colorado River
San Quintin
Angel de la Guarda
Tiburon
Cedros
32°
30°
28°
116°
114°
112°


O N A
N E W M E X I
EL PASO
RIO GRANDE


104°
102°
100°
C
O
SCALE
5 0 5 10 15 MILES
YUMA SAND HILLS
SOUTHERN PACIFIC R.R.
U.S. HWY 80
ALL AMERICAN CANAL
ALL AMERICAN
S.P. RR
YU
River

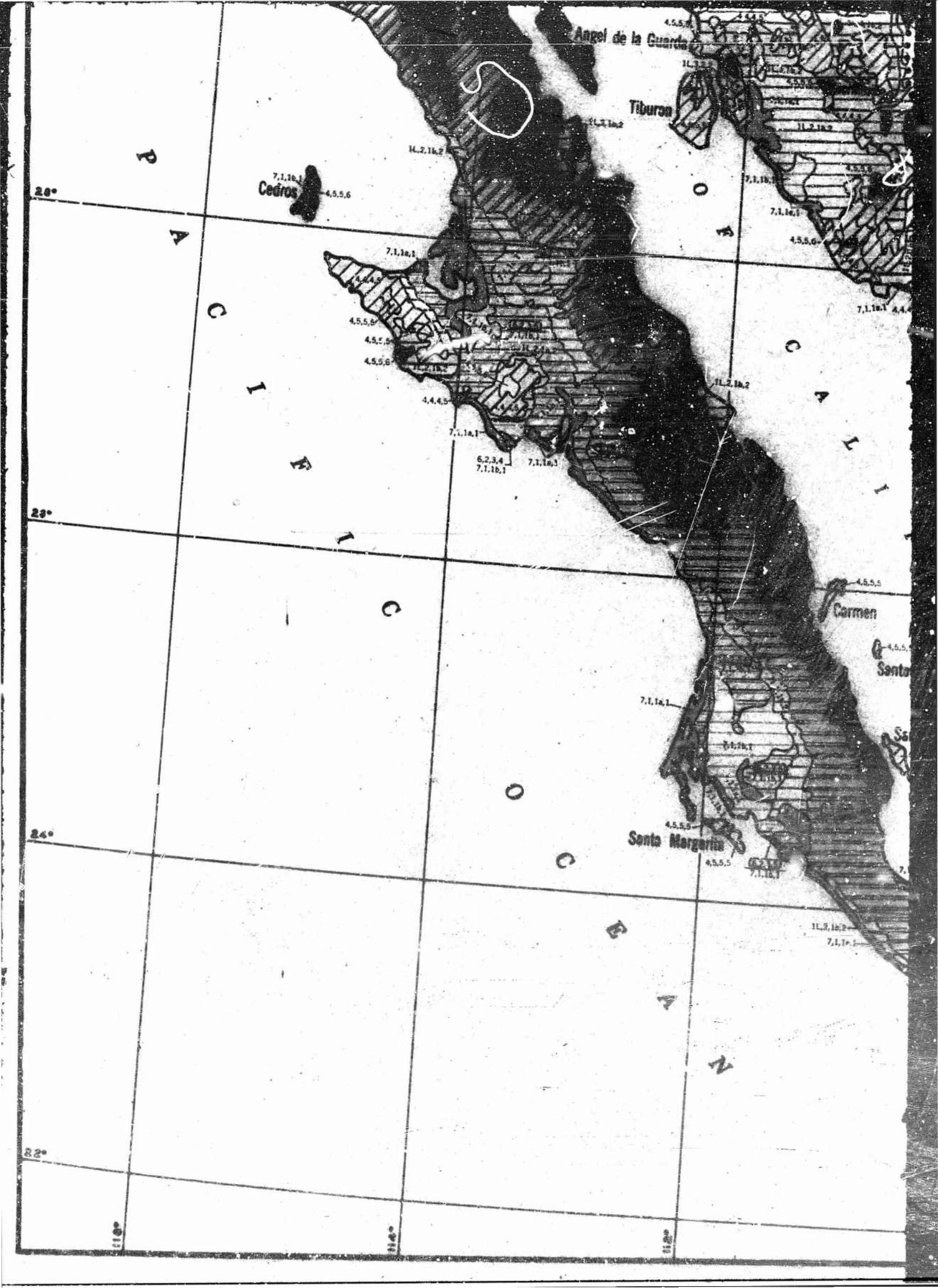


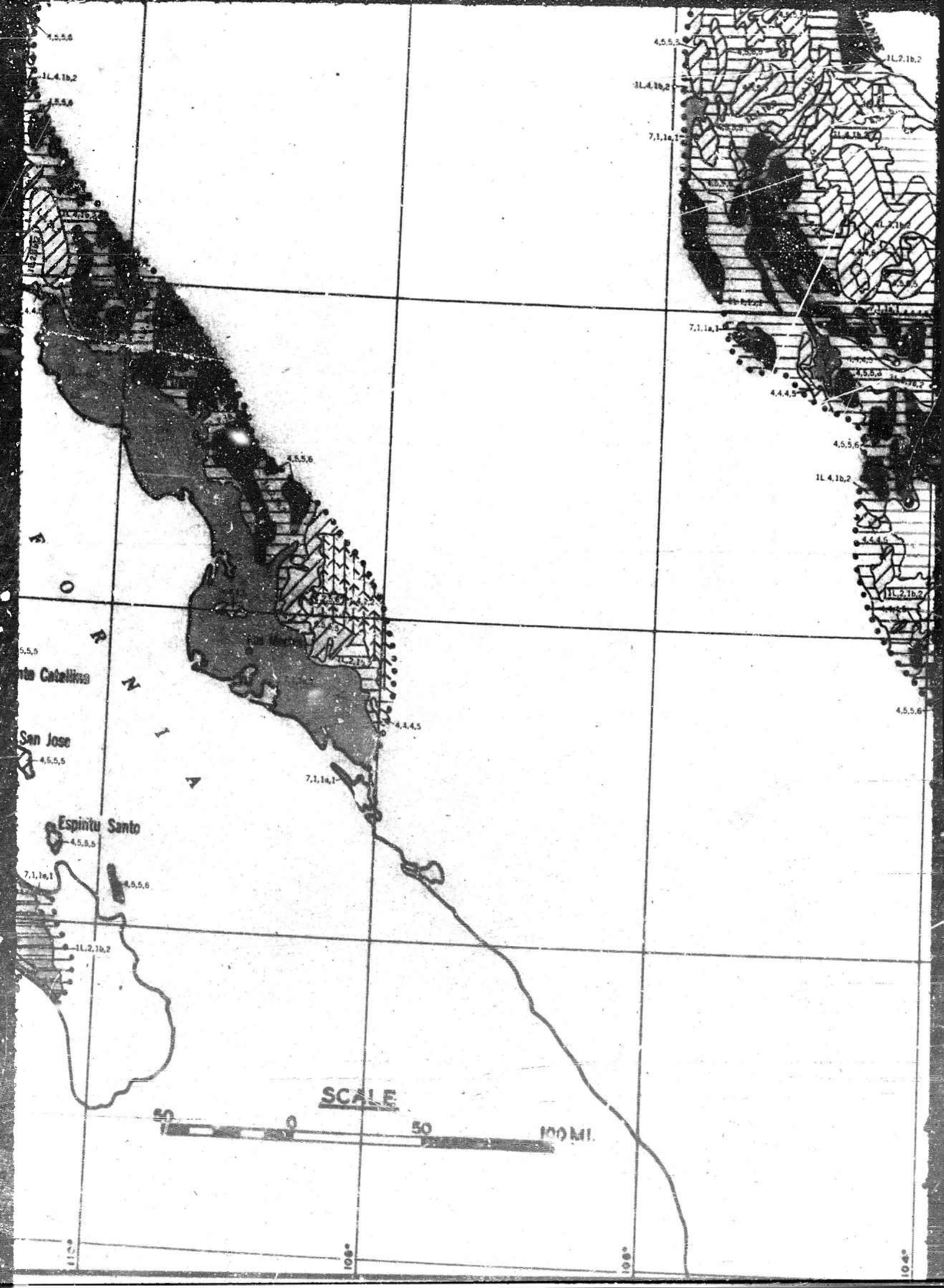
YUMA TEST STATION

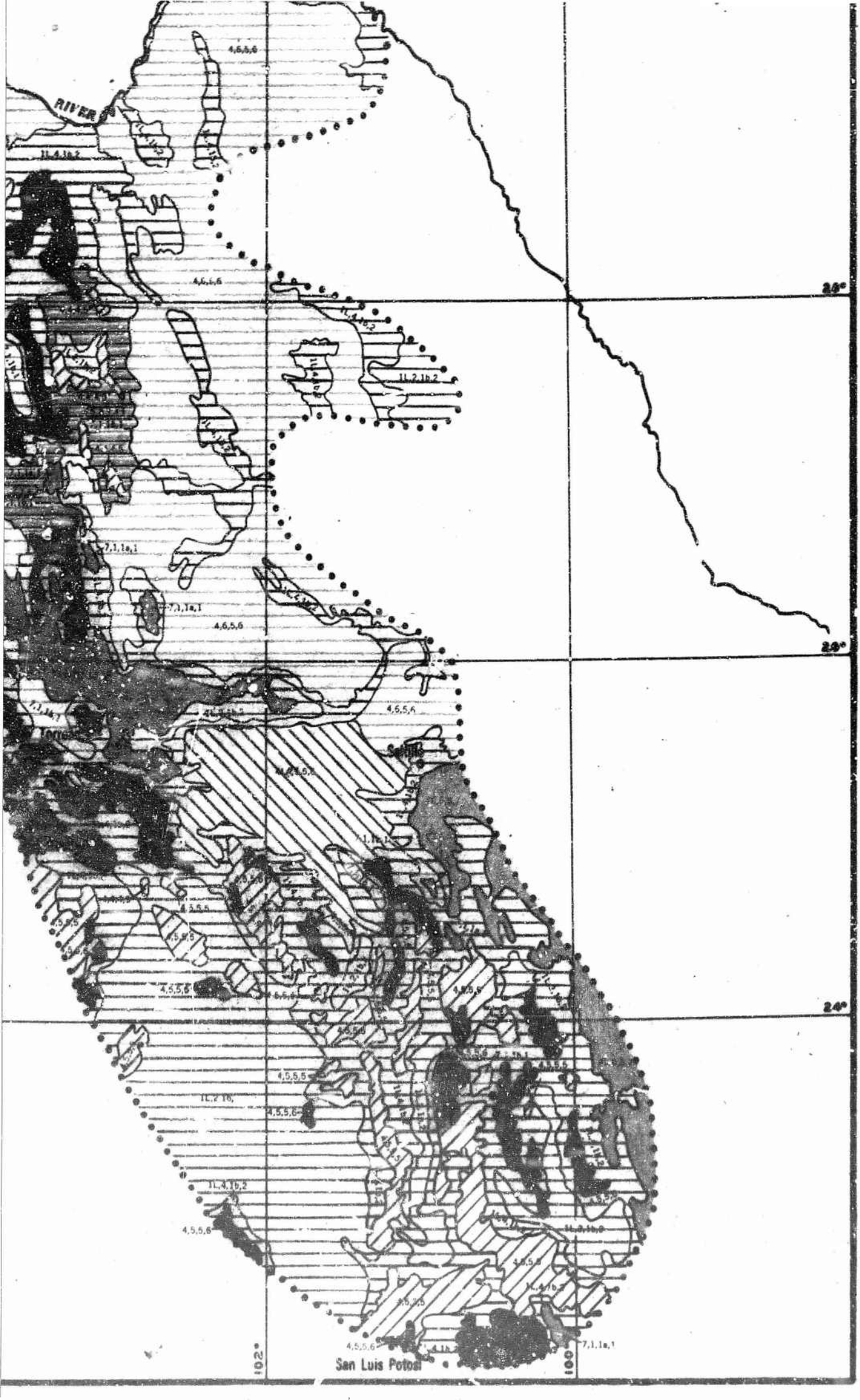
GENERALIZED LANDSCAPE

MEXICO PP	MEXICO SO	MEXICO CS	MEXICO CR		YUMA PP	YUMA SO	YUMA CS	YUMA CR	Typical Landform
MOUNTAINS									
4	6	5	6		4	6	5	6	Rugged mountains
4	6	5	7		4	6	5	7	Rugged mountains
4L	6	5	7		4L	6	5	7	Rugged mountains
4	5	5	6		4	5	5	6	Mod. rugged mountains
4L	5	5	6						Parallel ridge mountains
4	5	5	5		4	5	5	5	Mod. rugged mountains or rugged hills
4	3	4	6						Volcanic cones
					7	1	5	7	Basin range
HILL LANDS									
4	4	4	5						Mod. rugged hills
					4	5	3	5	Mod. rugged hills
4	5	4	5		4	5	4	5	Mod. rugged hills
					4	6	3	5	Rugged hills
					4	6	4	5	Rugged hills
					4	6	5	5	Rugged hills
					4L	4	3	5	Transverse dunes
4	5	3	4		4	5	3	4	Complex dunes

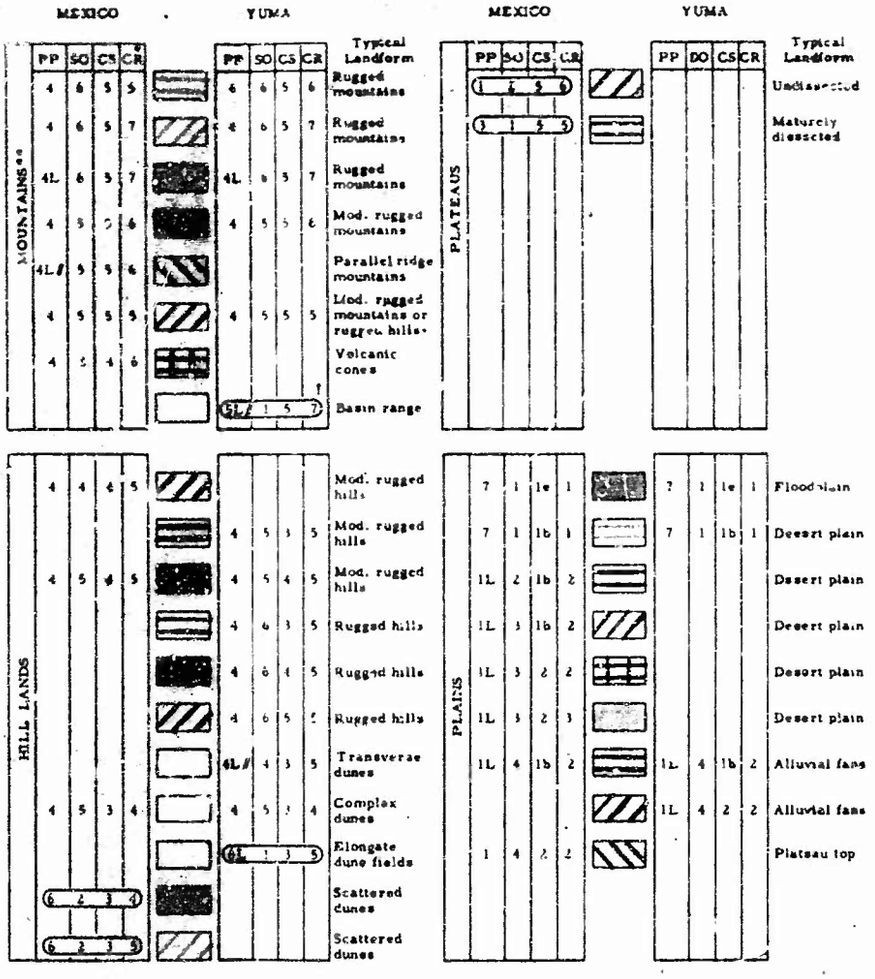
MEXICO PP	MEXICO SO	MEXICO CS	MEXICO CR		YUMA PP	YUMA SO	YUMA CS	YUMA CR	Typical Landform
PLATEAUS									
1	2	5	6						Undissected
3	1	5	5						Maturely dissected
PLAINS									
7	1	1a	1		7	1	1a	1	Floodplain
7	1	1b	1		7	1	1b	1	Desert plain
1L	2	1b	2						Desert plain
1L	3	1b	2						Desert plain
1L	3	2	2						Desert plain
1L	3	2	3						Desert plain
1L	4	1b	2		1L	4	1b	2	Alluvial fans
1L	4	2	3		1L	4	2	3	Alluvial fans


Angel de la Guarda
Tiburon
Cedros
Carmen
Santa Margarita
PACIFICO
OCEAN
CALIFORNIA
GULF OF
28°
26°
24°
22°


4,5,5,6
1L,4,1b,2
4,5,5,6
4,5,5,3
1L,2,1b,2
3L,4,1b,2
7,1,1a,1
4,4,4,5
4,5,5,6
1L,4,1b,2
4,4,4,5
1L,2,1b,2
4,5,5,6
4,5,5,6
4,4,4,5
7,1,1a,1
Espiritu Santo
4,5,5,5
7,1,1a,1
4,5,5,6
1L,2,1b,2
SCALE
50
0
50
100 MI.
108°
106°
104°

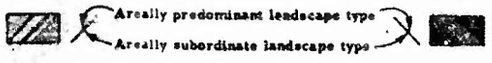

RIVER
4,6,5,6
IL,4,1b,2
IL,2,1b,2
7,1,1a,1
4,5,5,6
IL,2,1b,
IL,4,1b,2
4,5,5,5
28°
26°
24°
102°
100°
San Luis Potosí

GENERALIZED LANDSCAPE



LANDSCAPE COMPLEXES

Areal Complexes: Mapped in areas where two major, areally restricted landscape types occur.



Slope of fraction line depends on type of complex found in occurrence, slope, and relief.

Gross-component Complexes: Confined to areas where a gross and a component plan-profile are mapped.

* PP, SO, CS, and CR designate plan-profile, slope occurrence, characteristic slope, and characteristic relief. Numbers in columns identify mapping units of each terrain factor.

† A circled series of numbers identifies a gross landscape type.

** Major groupings of generalized landscapes are based on physiography for convenience only. It should be realized that surface geometry is often entirely independent of physiographic association.

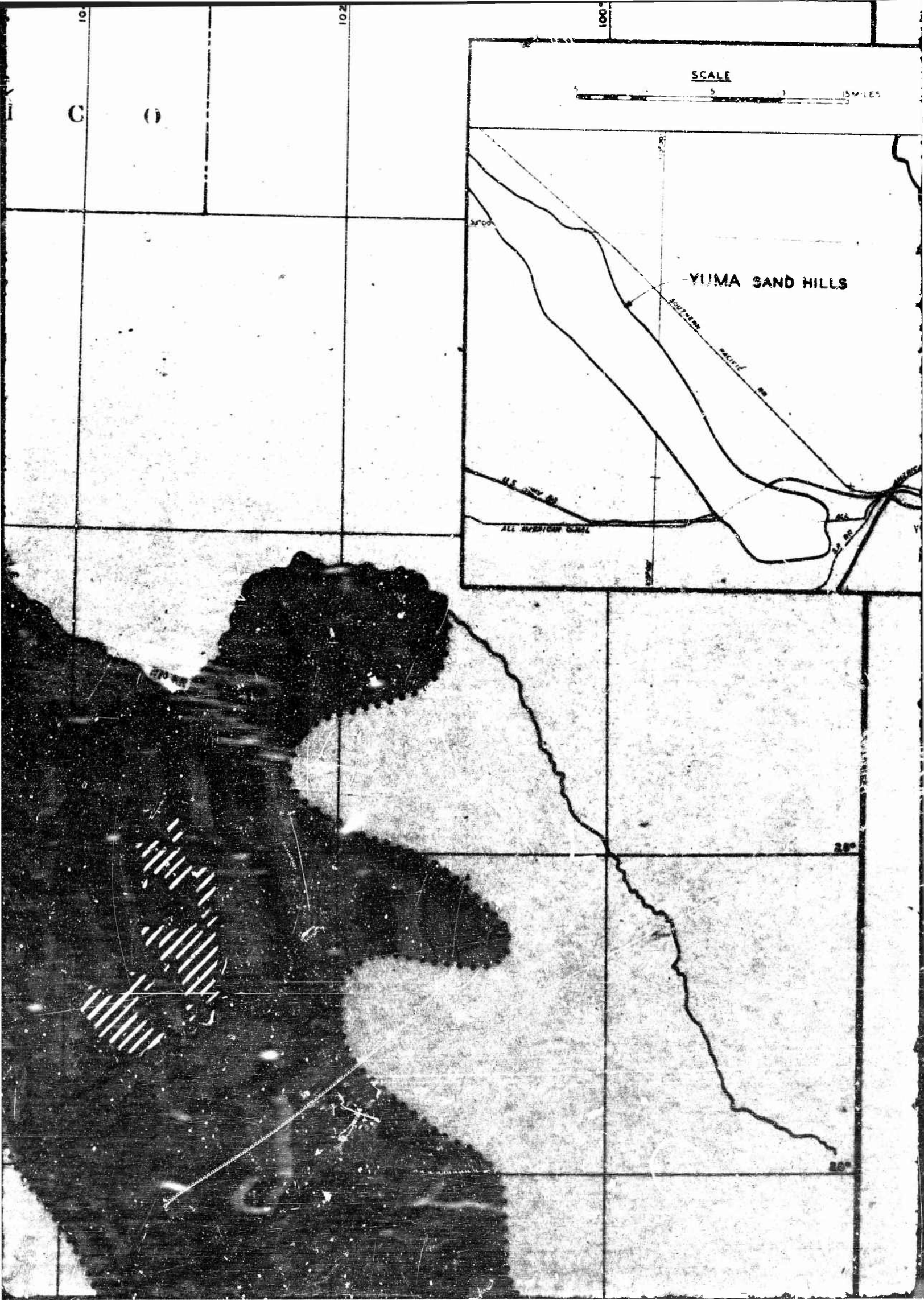
ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

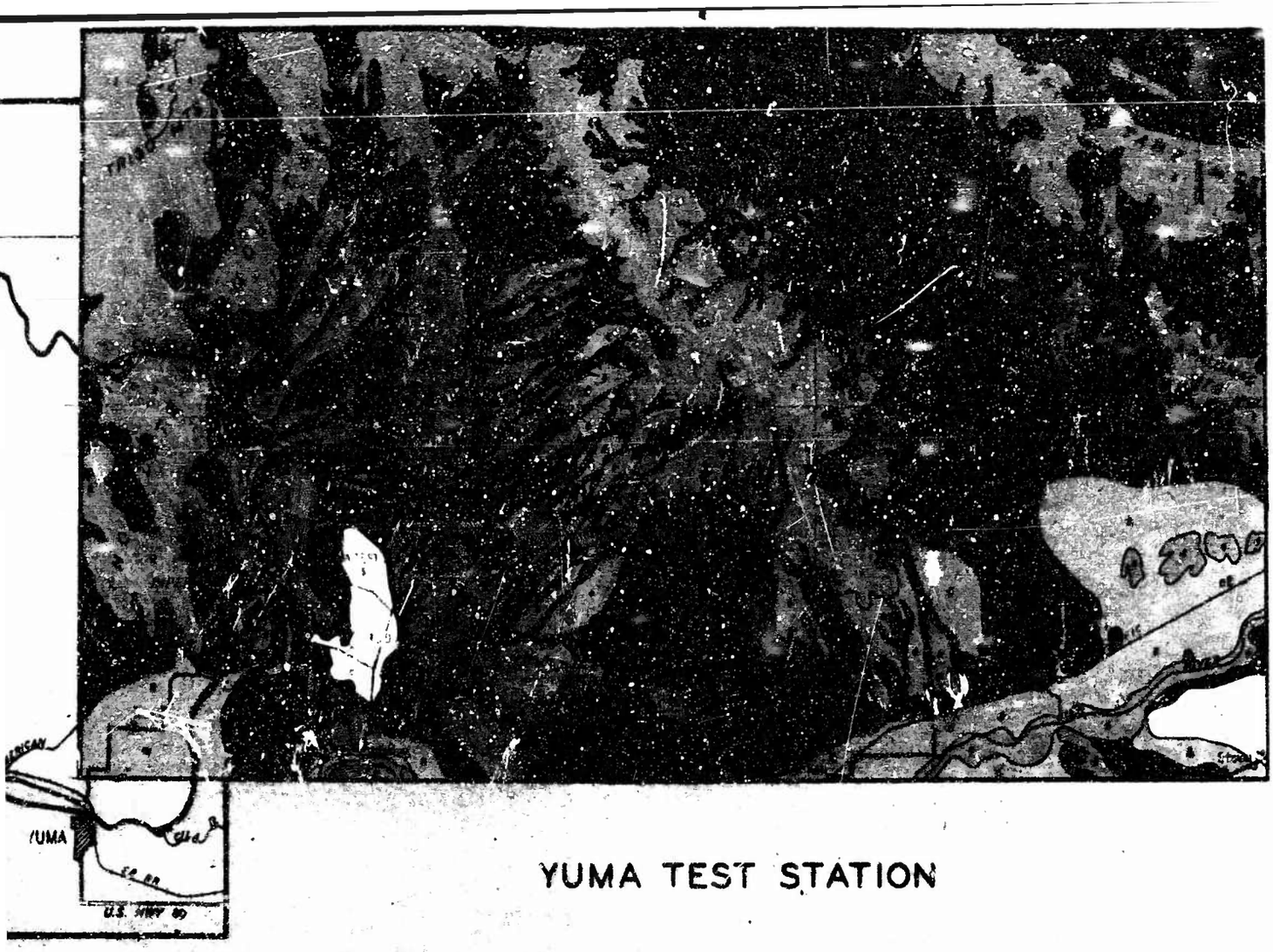
GENERALIZED LANDSCAPE

PLATE 5


CALIFORNIA
ARIZ
32°
30°
28°
26°
San Quintin
Cedros
Tiburon
Carmen
PACIFIC


O N A
N E W M E X I
110°
109°
106°
EL PASO
RIO GRANDE
Santa Catalina


SCALE
5
0
15 MILES
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
32°
33°



YUMA TEST STATION

SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1 — Areas characterized by a mosaic of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 90 per cent of the area mapped.

2 — Areas characterized by a mosaic of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 - 90 per cent of the area mapped.

3 — Areas characterized by a mosaic of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 20 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of volcanic ash or ejecta.

*Stony soils: More than 75 per cent of a typical sample consists of material coarser than gravel.
Coarse-grained soils: More than 50 per cent of a typical sample consists of sand and/or gravel.
Fine-grained soils: More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS

Areally predominant (75 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils.

COARSE-GRAINED SOILS

4 — Gravel: More than 90 per cent of a typical sample consists of gravel.

5 — Sand: More than 90 per cent of a typical sample consists of sand.

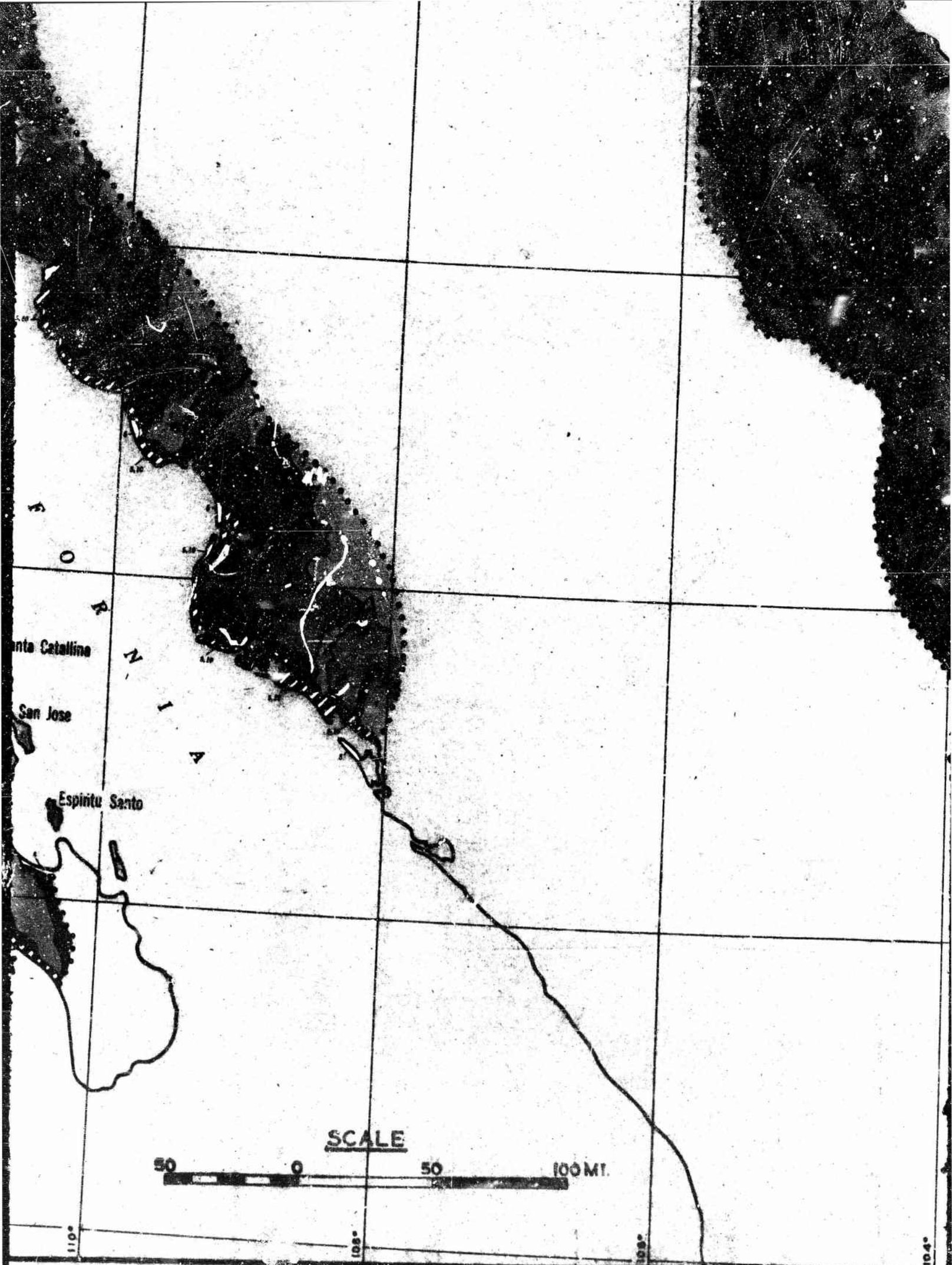
6 — Sand and gravel mixed with minor amounts of finer materials: More than 50 per cent of a typical sample consists of sand and/or gravel.

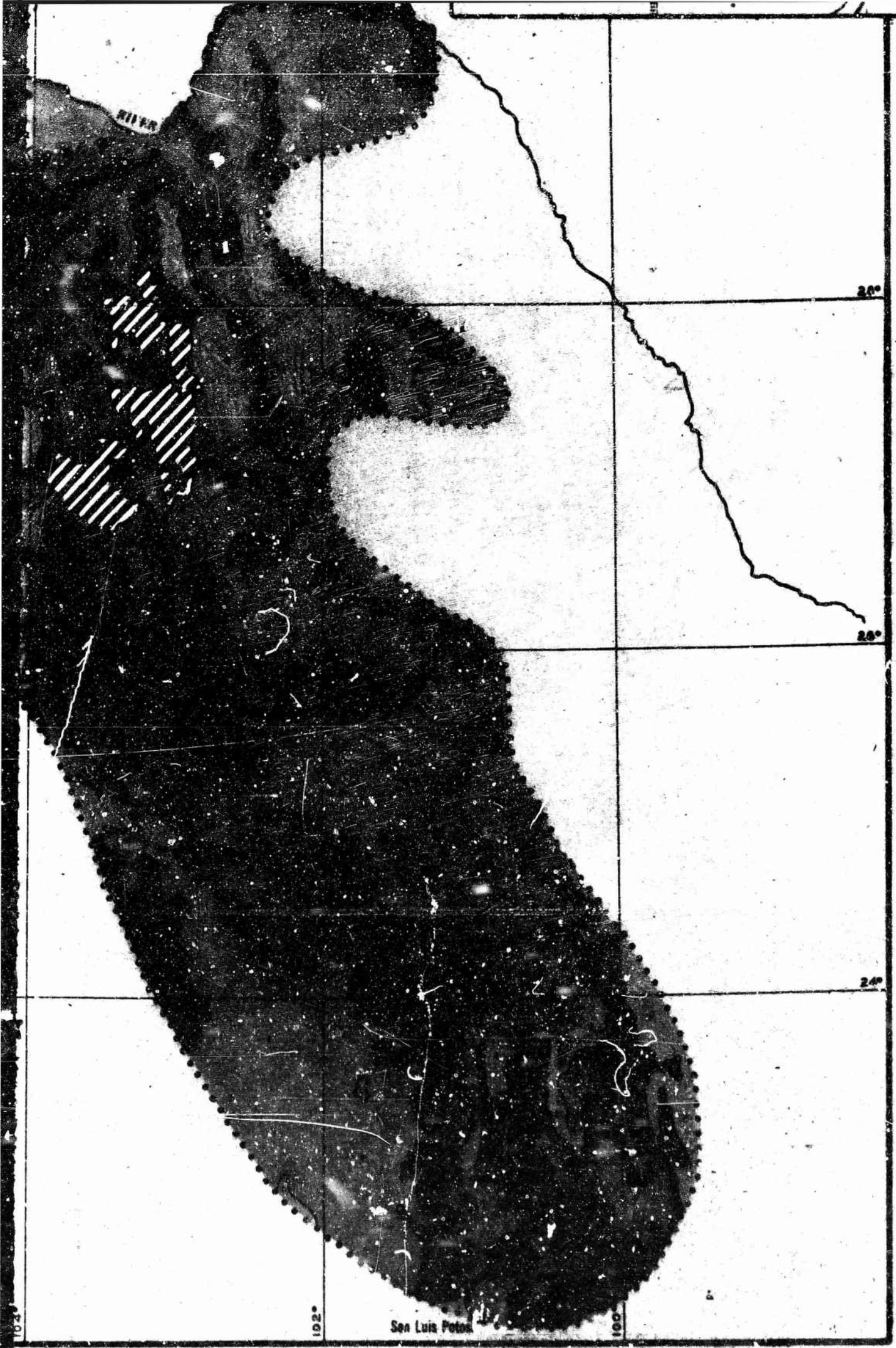
FINE-

7 — Silt and clay with minor amounts of coarser materials: More than 50 per cent of a typical sample consists of silt and/or clay.

8 — Silt: More than 75 per cent of a typical sample consists of silt.


Tiburon
Cedros
Carmen
Santa Margarita
PACIFIC OCEAN
CALIFORNIA
28°
26°
24°
22°
116°
114°
112°


F O R N I A
nta Catalina
San Jose
Espiritu Santo
SCALE
50 0 50 100 MI.
110°
108°
106°
104°


RIVER
25°
24°
102°
San Luis Potosí
100°

SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1 — Areas characterized by a mosaic of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 90 per cent of the area mapped.

2 — Areas characterized by a mosaic of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 - 90 per cent of the area mapped.

3 — Areas characterized by a mosaic of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 20 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of volcanic ash or ejecta.

*Stony soils: More than 75 per cent of a typical sample consists of material coarser than gravel.
Coarse-grained soils: More than 50 per cent of a typical sample consists of sand and/or gravel.
Fine-grained soils: More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS

Areally predominant (70 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils.

COARSE-GRAINED SOILS

4 — Gravel: More than 90 per cent of a typical sample consists of gravel.

5 — Sand: More than 90 per cent of a typical sample consists of sand.

6 — Sand and gravel mixed with minor amounts of finer material: More than 50 per cent of a typical sample consists of sand and/or gravel.

FINE-GRAINED SOILS

7 — Silt and clay with minor amounts of coarser material: More than 50 per cent of a typical sample consists of silt and/or clay.

8 — Silt: More than 75 per cent of a typical sample consists of silt.

9 — Clay: More than 75 per cent of a typical sample consists of clay.

10 — Saline: A typical soil sample has a salt content of more than 25 per cent—usually associated with silt and clay.

SOIL COMPLEXES: Soil complexes are mapped in areas where two dominant soil types occur; the areally predominant of these two is shown as the numerator, the areally subordinate as the denominator in the fractional pattern.

In complexes (e.g., 4/6) the first digit always refers to the areally predominant unit.

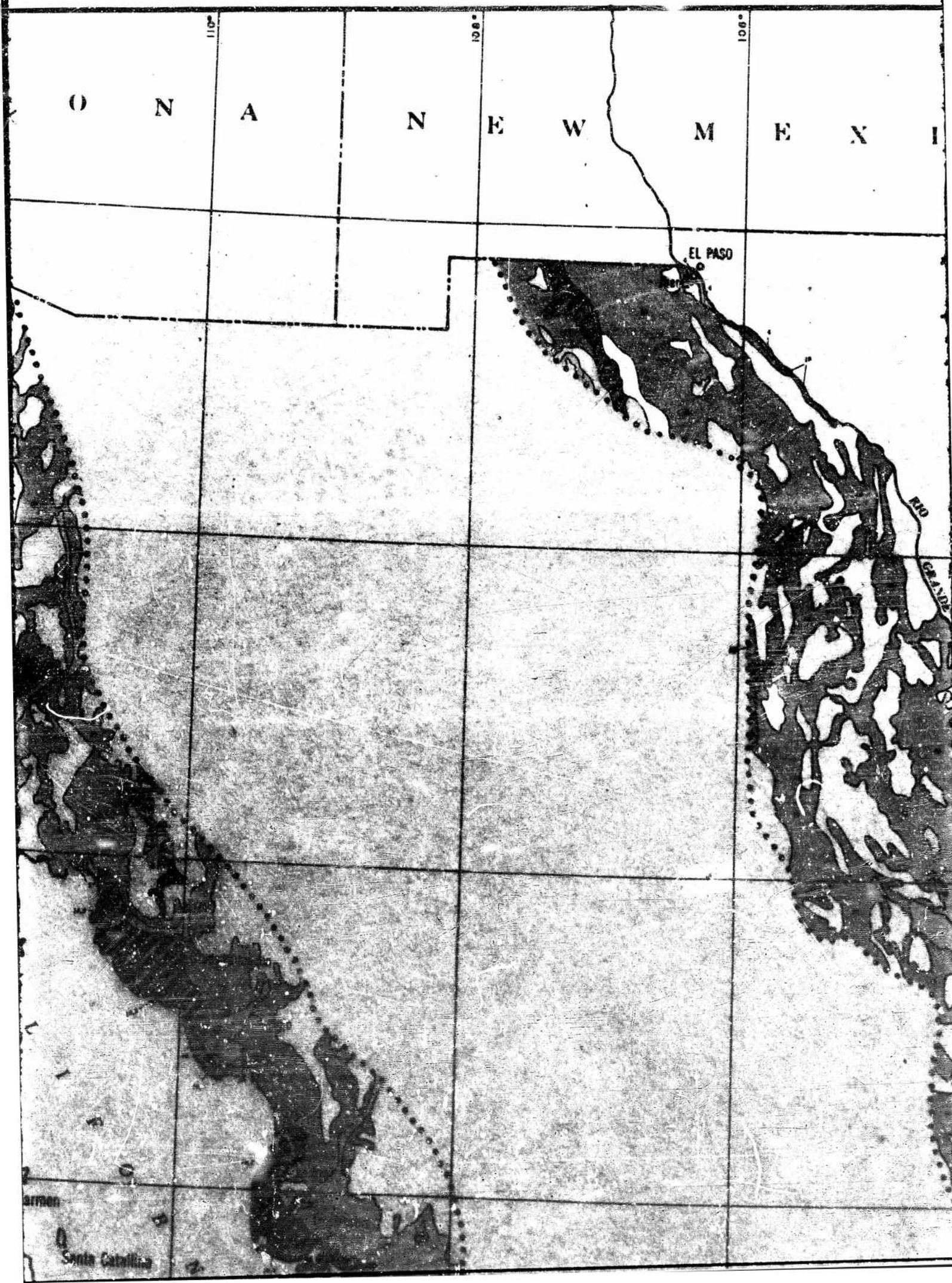
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

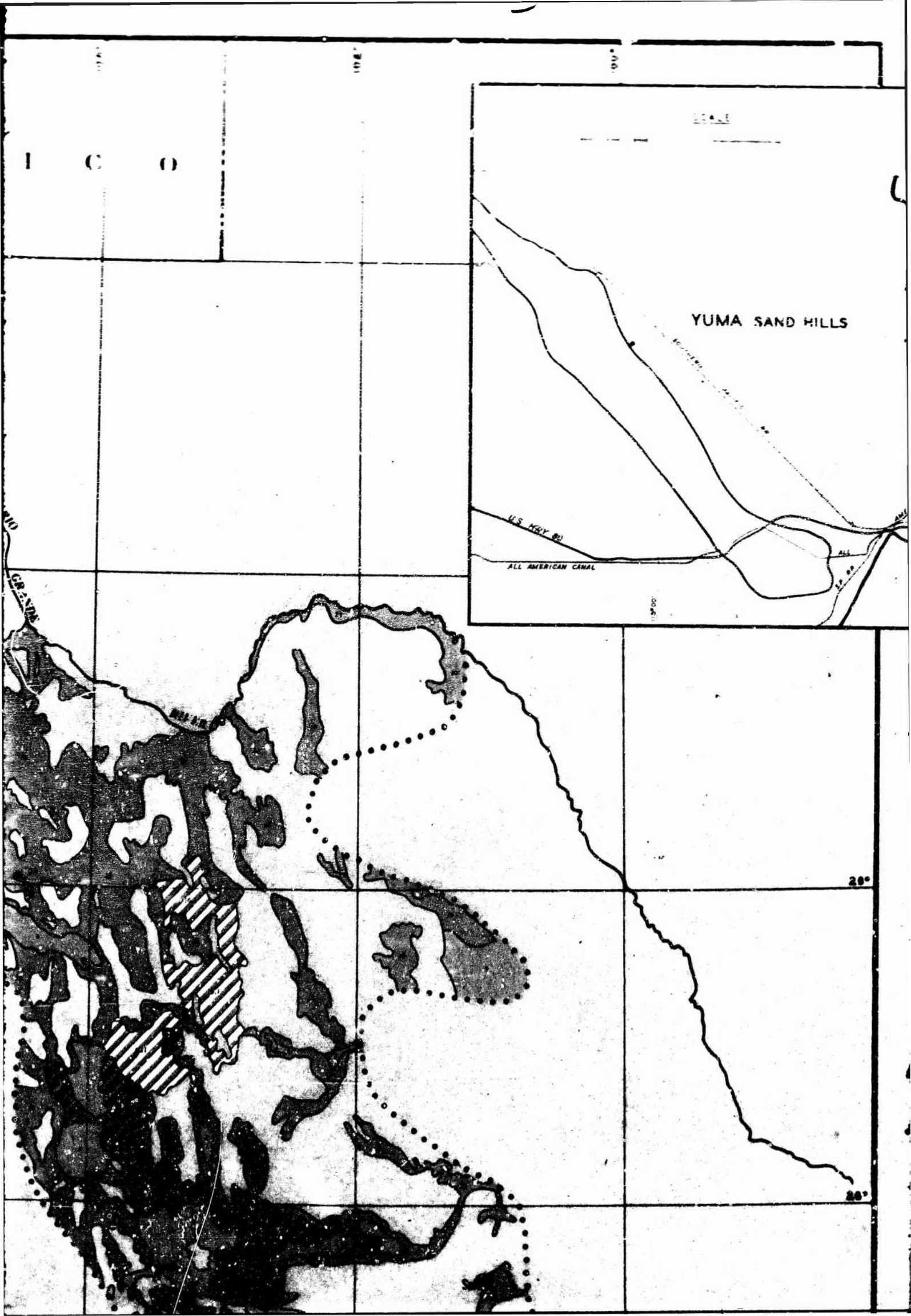
SOIL TYPE

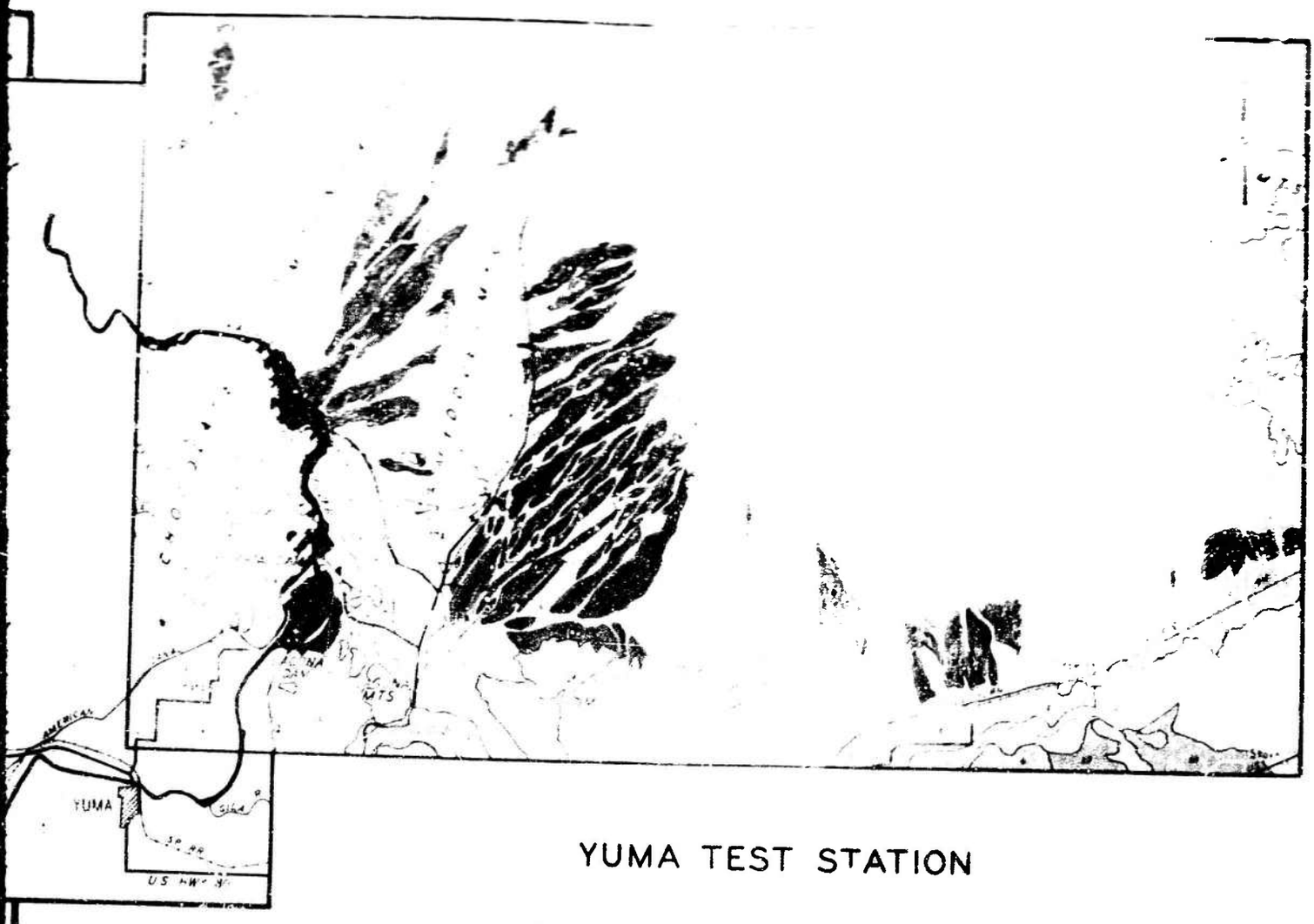
8

PLATE 8


CALIFORNIA
ARIZ
116°
114°
112°
32°
30°
28°
26°
San Quintin
Tiburon
Cedros
Carmen


O N A
N E W M E X I
EL PASO
RIO GRANDE
Santa Catalina


YUMA SAND HILLS
U.S. HWY 80
ALL AMERICAN CANAL
GRANDE
RIO
28°
26°



YUMA TEST STATION

SOIL CONSISTENCY

Soil consistencies are mapped only where soil associations occur. Areally predominant (70 per cent or more) soil consistency mapped.

I. HOMOGENEOUS CONSISTENCIES: Soils of essentially unchanged consistencies to depths greater than 18 inches.

A. **Noncohesive**: Materials in which the constituent particles do not adhere to each other.

1 **Loose**: The ratio of voids to constituent grains is close to a naturally occurring maximum, i.e., the grains are loosely packed.

2 **Dense**: The ratio of voids to constituent particles is close to a naturally occurring maximum, i.e., the grains are closely packed.

B. **Cohesive**: Materials in which the constituent particles adhere to each other, either because of mutual attraction of the particles themselves, or because of the presence of a cementing material.

3 **Soft (usually perennially wet)**: Little or no bearing capacity.

4 **Firm**: Moderate bearing capacity.

5 **Hard**: High bearing capacity.

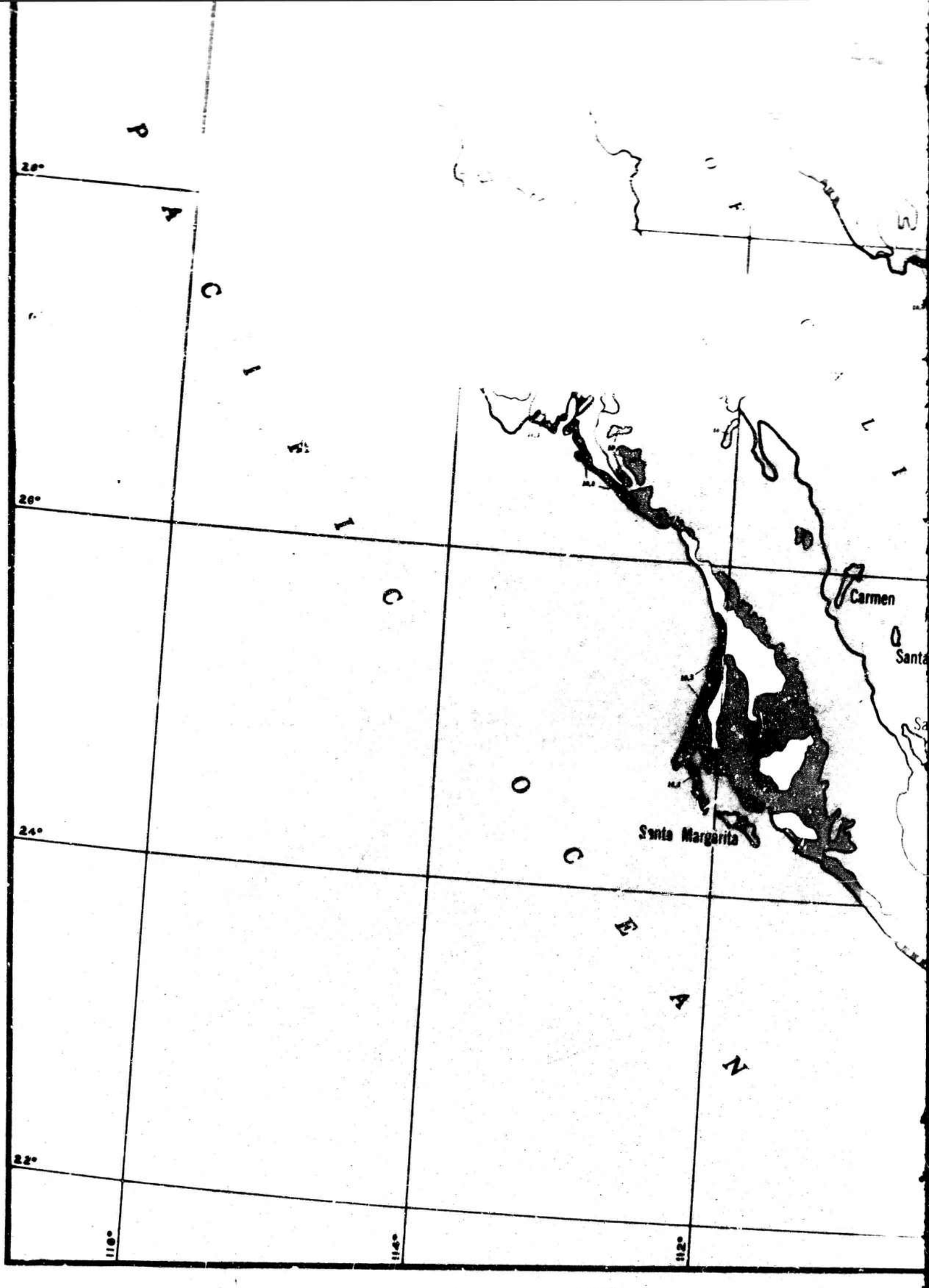
II. LAYERED CONSISTENCIES: Soils possessing two or more relatively discrete layers within 12 inches of the surface.

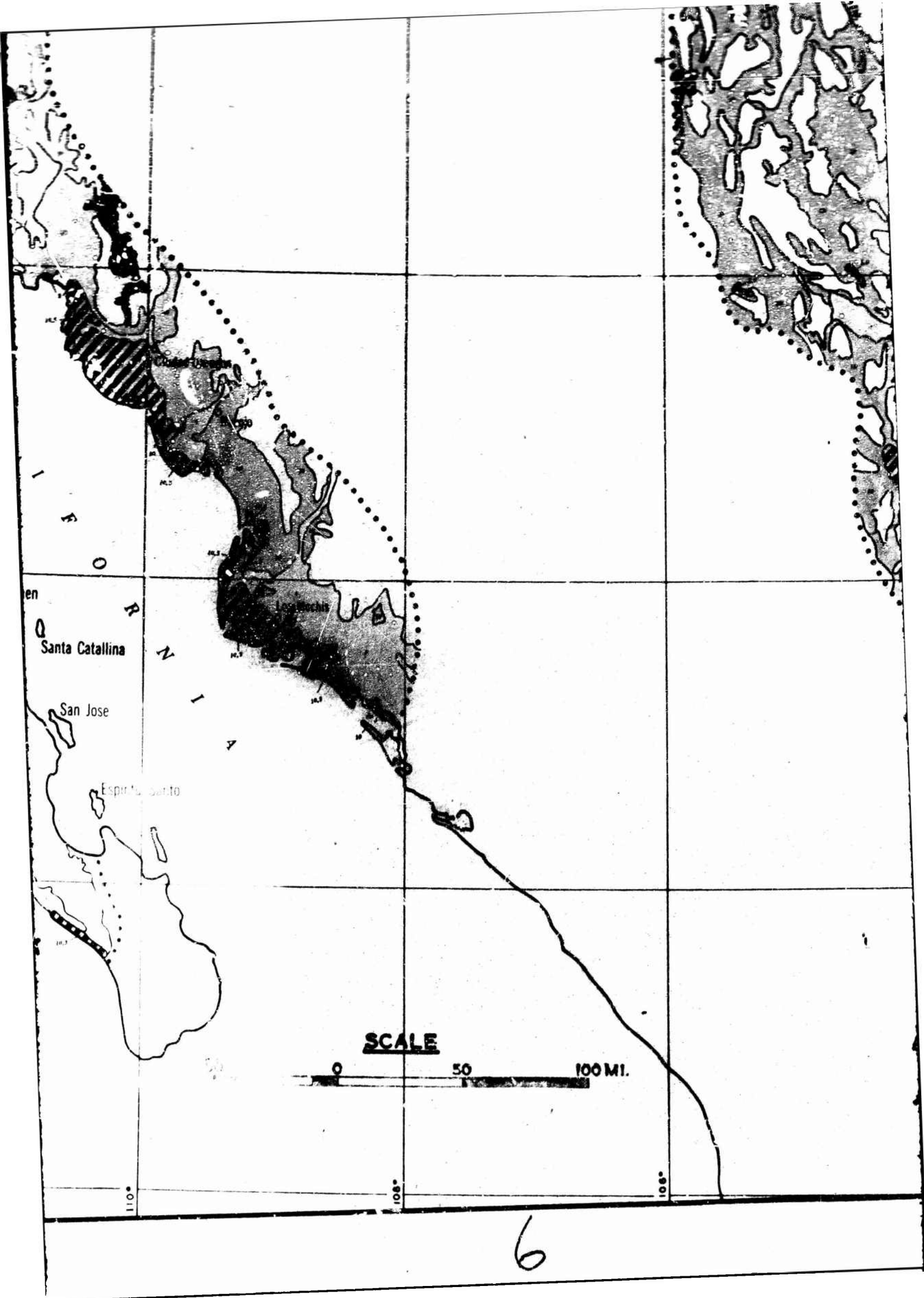
A. **Crusted surfaces**: Surface crust may be either cohesive or noncohesive.

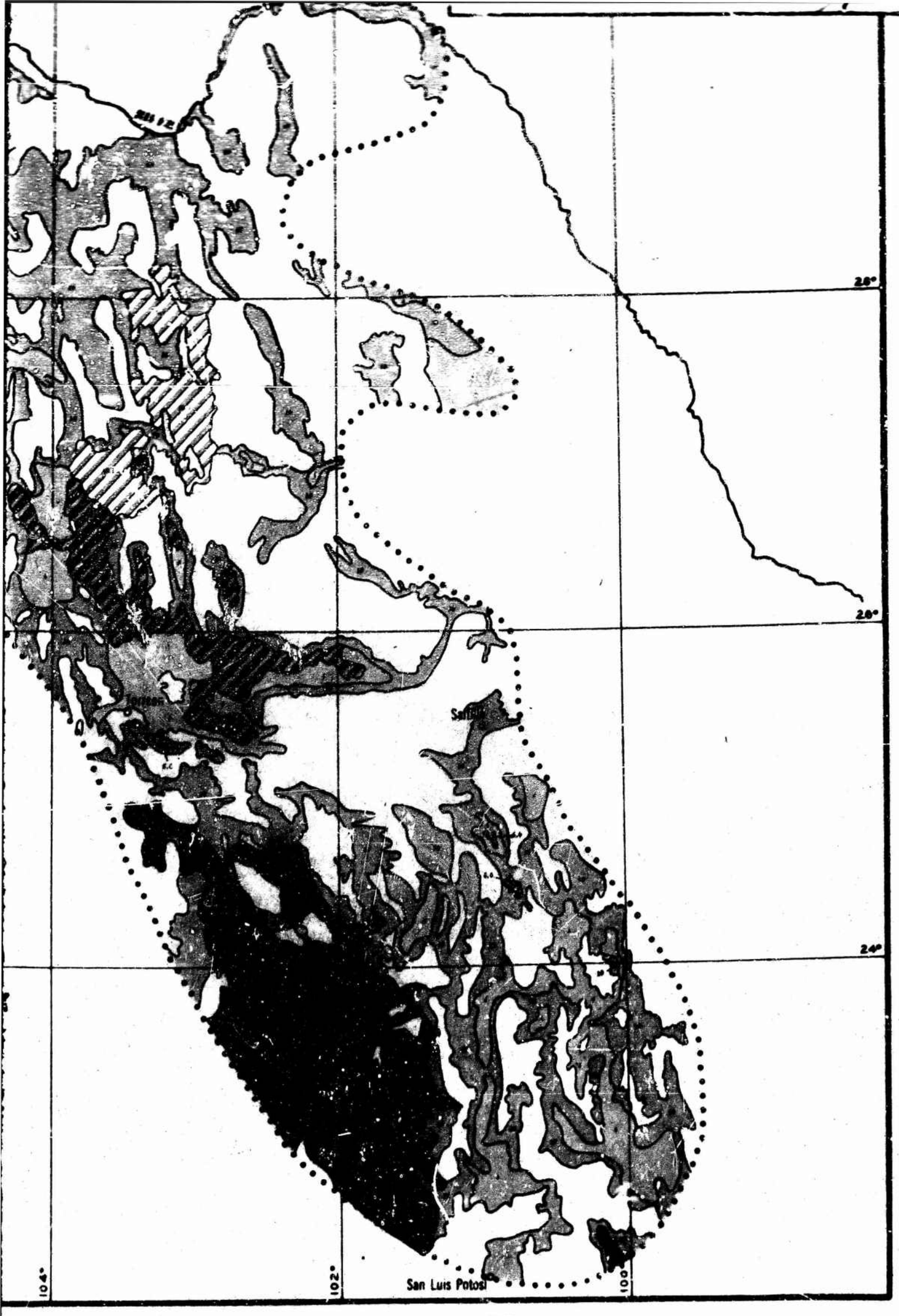
6 **Hard** thin crust (commonly of cemented materials) overlying soft materials (commonly mucky, pasty, or saturated silts).

7 **Hard** crust (commonly of cemented materials) overlying noncohesive material (commonly sand or silt).

8 **Surface of closely-fitted noncohesive pebbles or gravel overlying noncohesive materials** (commonly sand or silt). (Such "desert pavements" also occur


P A C I F I C
O C E A N
Carmen
Santa Margarita
28°
26°
24°
22°
118°
114°
112°


Santa Catallina
San Jose
SCALE
0
50
100 MI.
110°
108°
106°


28°
28°
24°
104°
102°
100°
San Luis Potosí

SOIL CONSISTENCY

Soil consistencies [illegible] are mapped [illegible] and associations [illegible]. Areally predominant [illegible] consistency mapped.

I. HOMOGENEOUS CONSISTENCIES: [illegible]

[illegible]

A. Noncohesive: [illegible]

[illegible]

1 Loose: The ratio of voids to constituent grains is cl[illegible] naturally occurring maximum, i.e., the grains are loosely packed.

2 Dense: The ratio of voids to constituent particles is close to a naturally occurring minimum, i.e., the grains are closely packed.

B. Cohesive: Materials in which the constituent particles adhere to each other either because of mutual attraction of the particles [illegible], or because of the presence of a cementing material.

3 Soft (usually perennially wet): Little or no bearing capacity.

4 Firm: Moderate bearing capacity.

5 Hard: High bearing capacity.

II. LAYERED CONSISTENCIES: Soils possessing two or more relatively discrete layers within 12 inches of the surface.

A. Crusted surfaces: Surface crust may be either cohesive or noncohesive.

6 Hard thin crust (commonly of cemented materials) overlying soft materials (commonly muck, ooze, or saturated silts).

7 Hard crust (commonly of cemented materials) overlying noncohesive material (commonly sand or silt).

8 Surface of closely-fitted noncohesive pebbles or gravel overlying noncohesive materials (commonly sand or silt). (Such "desert pavements" also occur over bedrock or materials of firm consistencies, but this is less common.)

9 Thin zone of firm materials over noncohesive materials. (Most common development in areas of fixed dunes, with more or less continuous vegetation cover.)

B. Noncohesive surface layer less than 18 inches thick.

10 Dense layer within 18 inches of the surface.

11 Hard layer within 18 inches of the surface (usually but not always caliche).

CONSISTENCY COMPLEXES: Consistency complexes are mapped in areas where two dominant consistencies occur; the areally predominant of these two is shown as the numerator, the areally subordinate as the denominator in the fractional pattern.

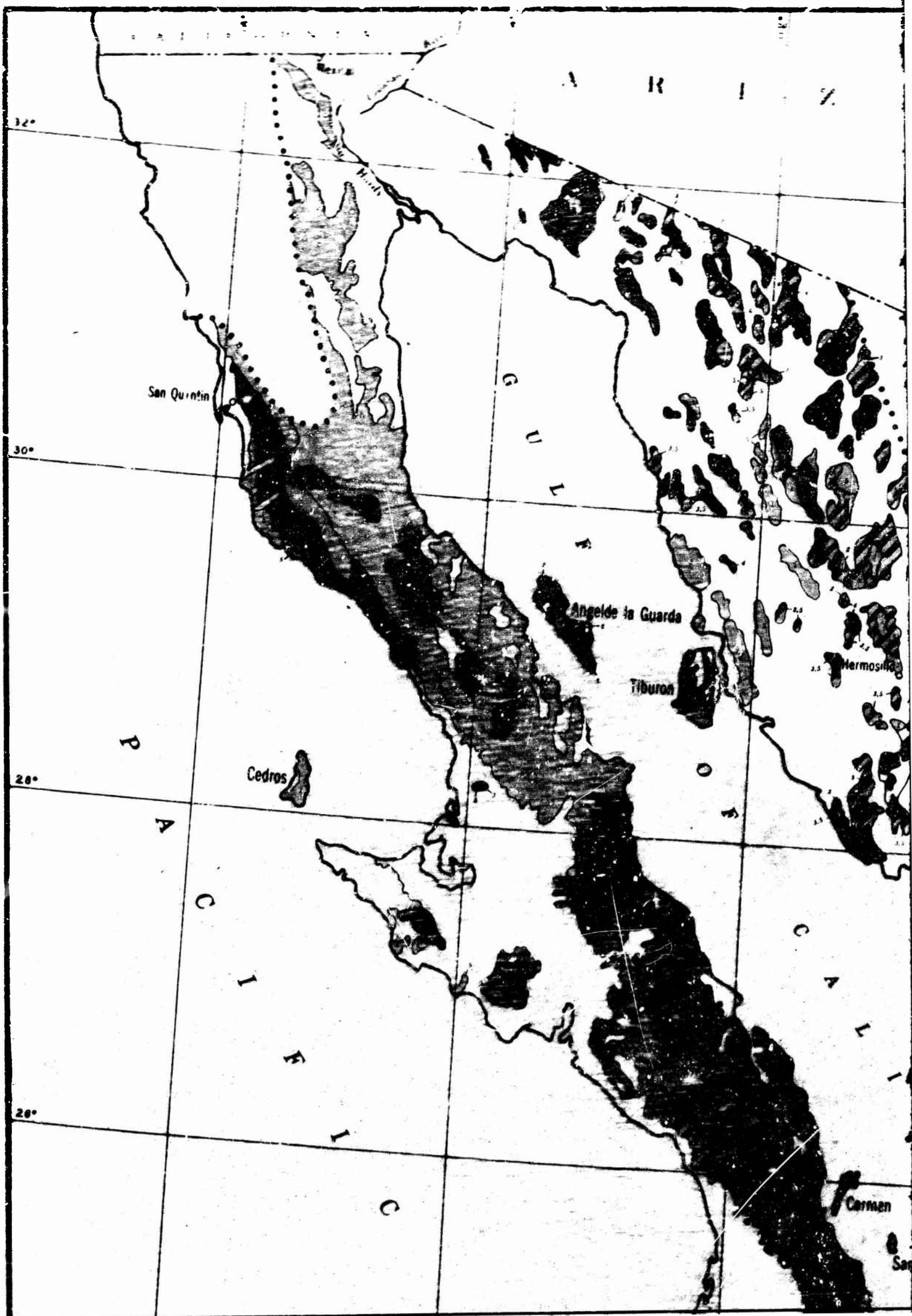
In complexes (e.g., 8/5) the first digit always refers to the areally predominant unit.

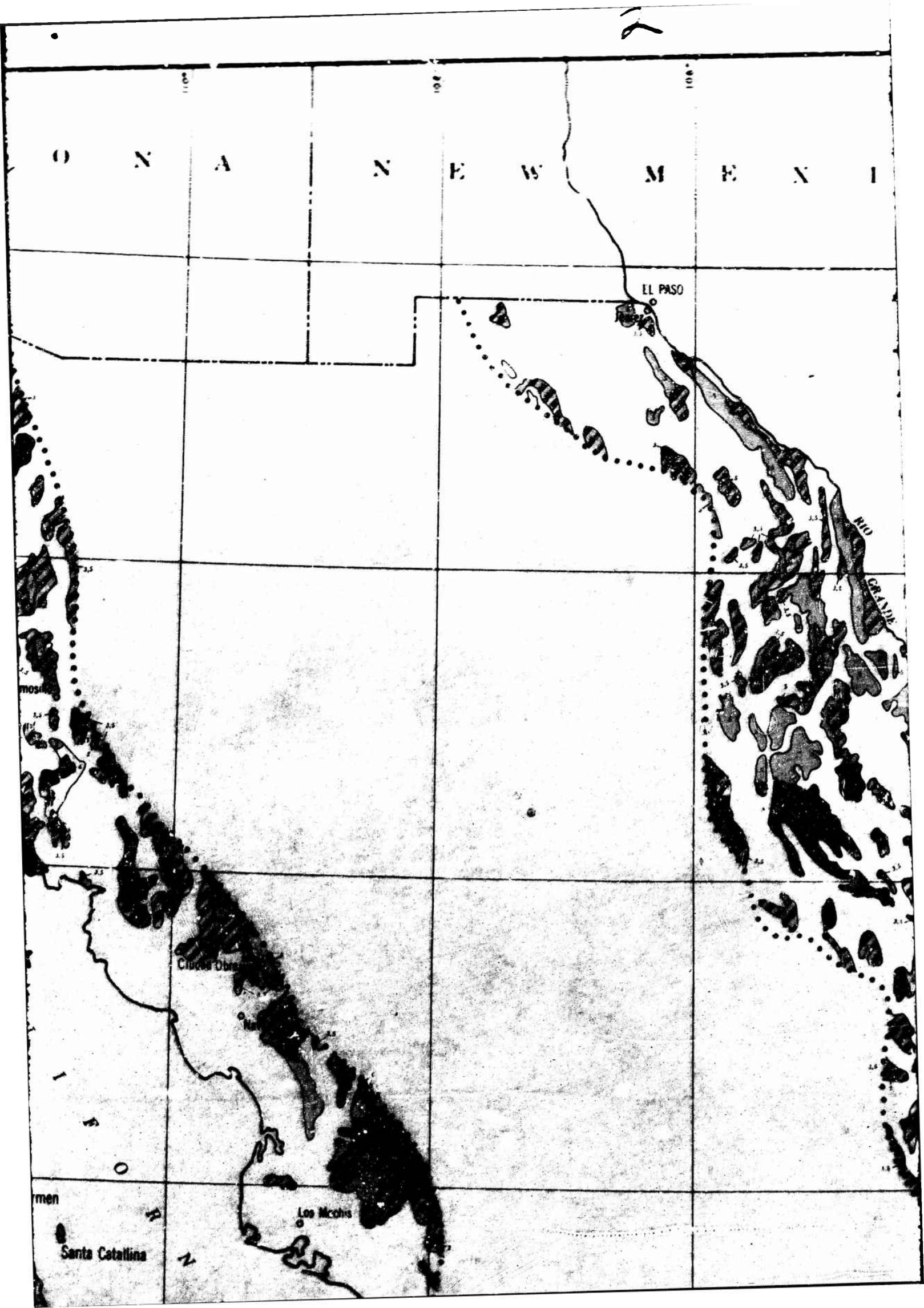
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

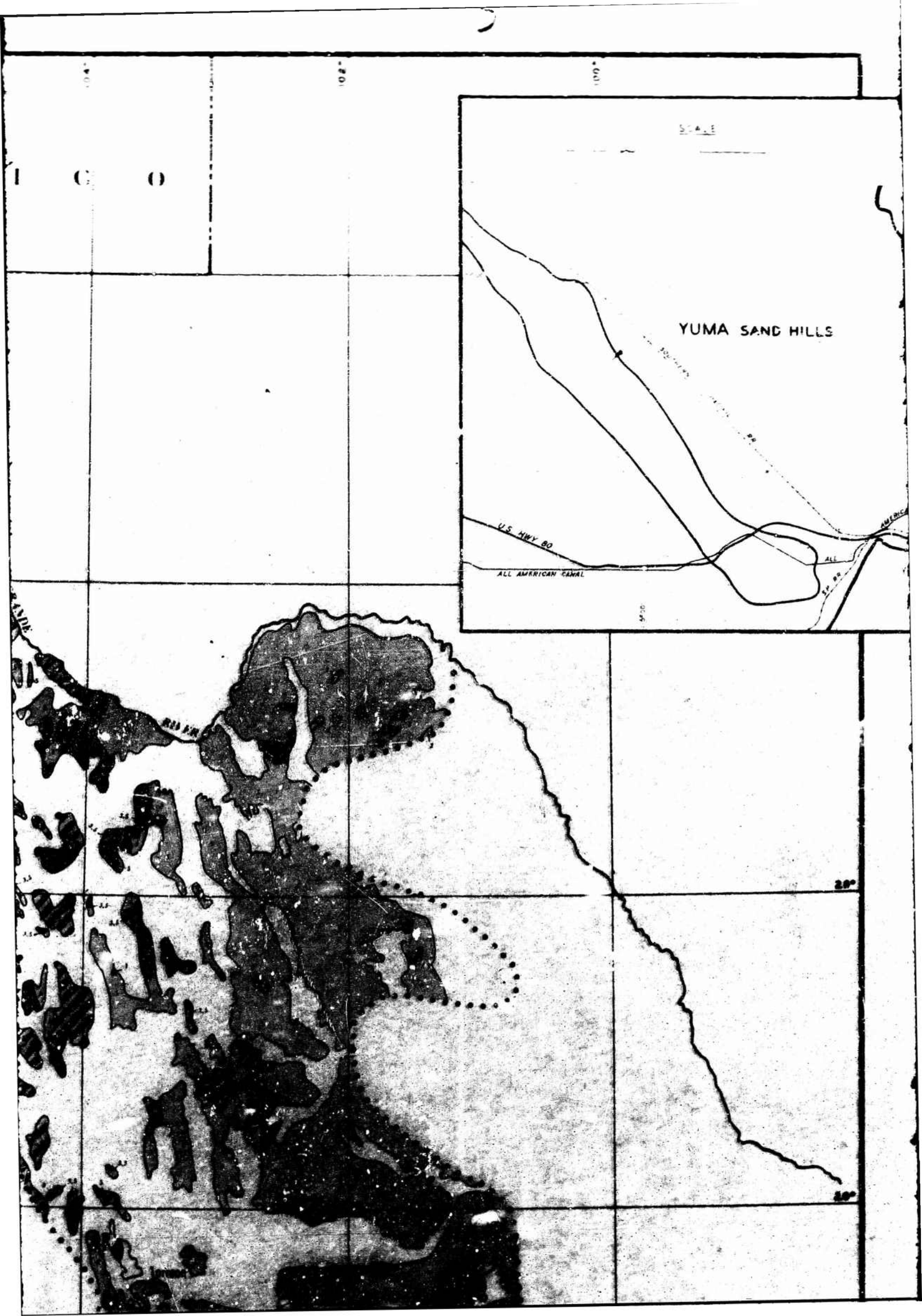
SOIL CONSISTENCY

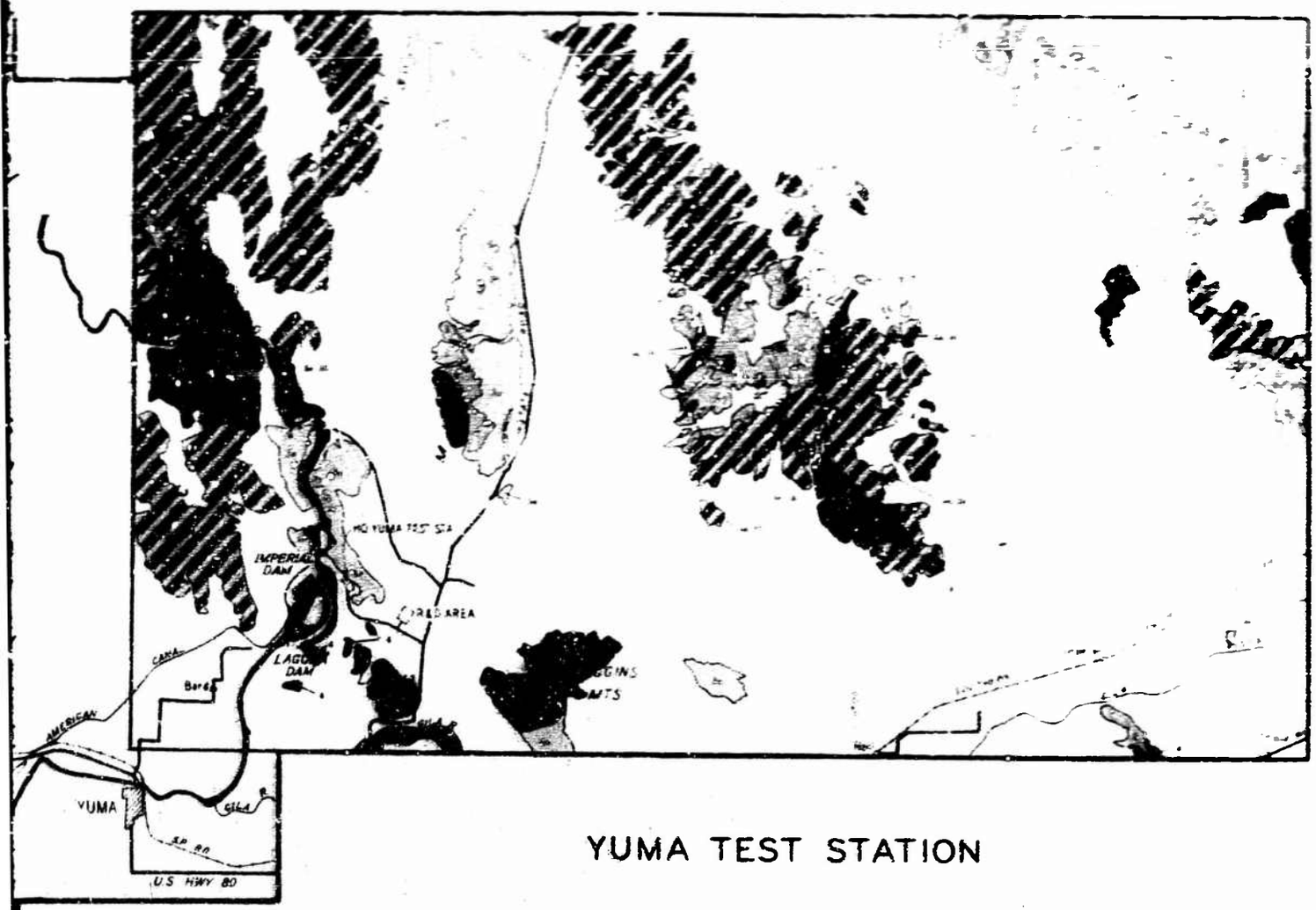
8

PLATE 7


32°
30°
28°
26°
San Quintin
Angel de la Guarda
Tiburon
Hermosillo
Cedros
Carmen
GULF OF CALIFORNIA
PACIFIC


EL PASO
RIO GRANDE
Los Mochis
Santa Catalina


SCALE
YUMA SAND HILLS
U.S. HWY 80
ALL AMERICAN CANAL
ALL
SP RR
32°
32°



YUMA TEST STATION

SURFACE ROCK

Mapped in regions where rock is exposed and at shallow depth (i.e., 0-10 feet)* throughout the remainder of the area. In effect this procedure restricts the occurrence of rocks to areas mapped as 1, 2, or 3 under Soil Type.

Areally predominant (70 per cent or more) rock type mapped.

1. IGNEOUS (UNDIFFERENTIATED): Rocks formed by solidification or crystallization of a hot fluid mass.

2. Intrusive: Igneous rocks, typically crystalline, which have formed by cooling below the surface of the earth. (Granite, syenite, diorite, etc.)

3. Extrusive (undifferentiated): Igneous rocks which have formed by cooling at the surface of the earth.

3a. Types: Massive rocks formed by solidification of fluid material (lava) erupted onto the surface of the earth (e.g., basalt, dacite, etc.).

3b. Rocks formed by aerodynamic cementation of loose deposits of volcanic ejecta (e.g., tuff, agglomerate, etc.)

4. METAMORPHIC (UNDIFFERENTIATED): Rocks formed from original igneous or sedimentary rocks through alterations produced by pressure, heat, or the infiltration of other materials at depths below the surface zones of weathering and cementation. The alterations are sufficiently complete throughout the body of the rock to produce a well-defined new type. (Gneiss, schist, slate, etc.)

5. SEDIMENTARY (UNDIFFERENTIATED): Rocks formed from material laid down in a more or less finely divided state, as sediment, through the agency of water, wind, or glaciers.

6. Sandstone: A sedimentary rock predominantly composed of sand grains cemented together.

7. Limestone: A sedimentary rock consisting essentially of calcium carbonate.

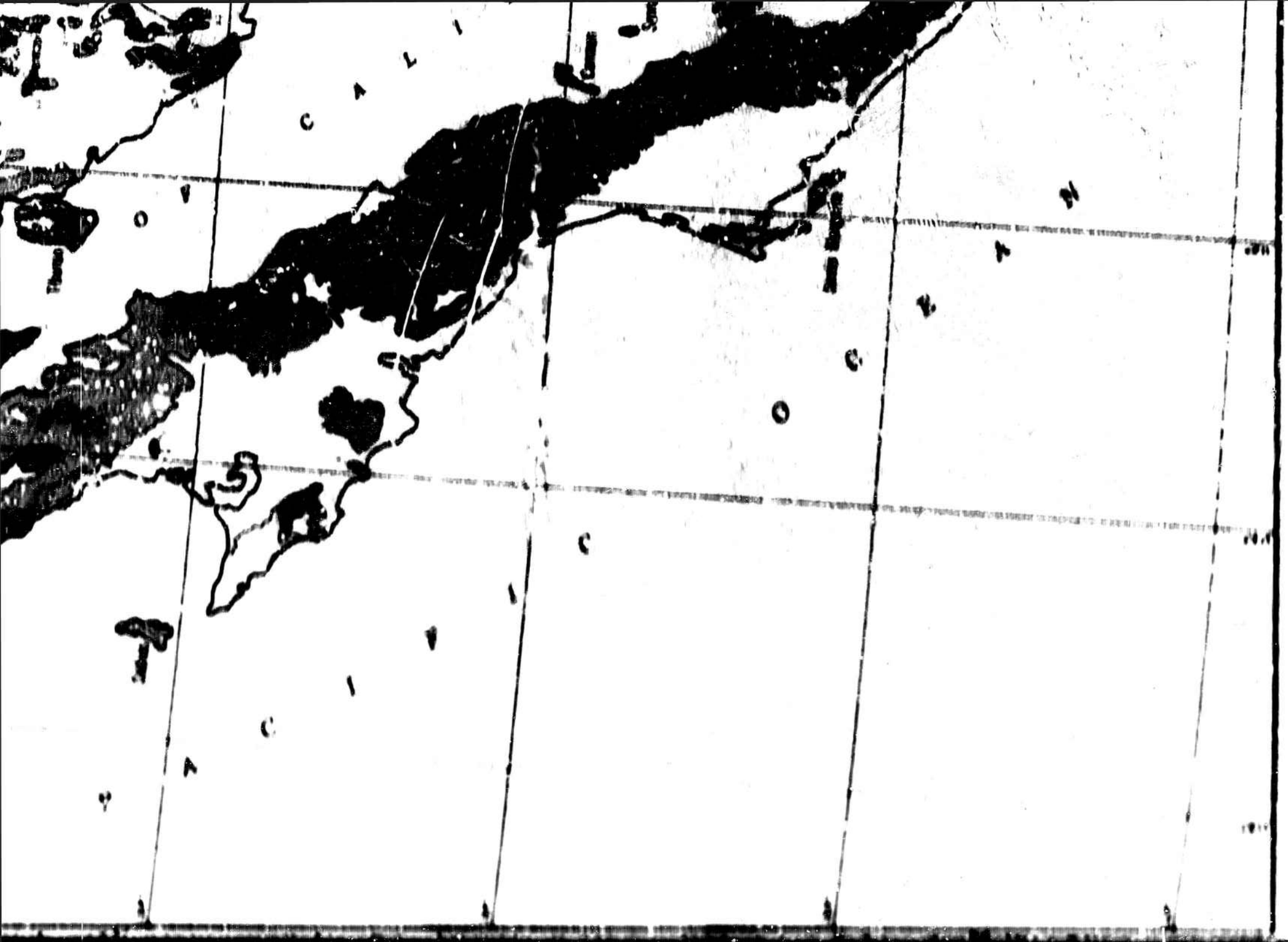
8. Shales: A sedimentary rock in which the constituent particles are predominantly of clay size.

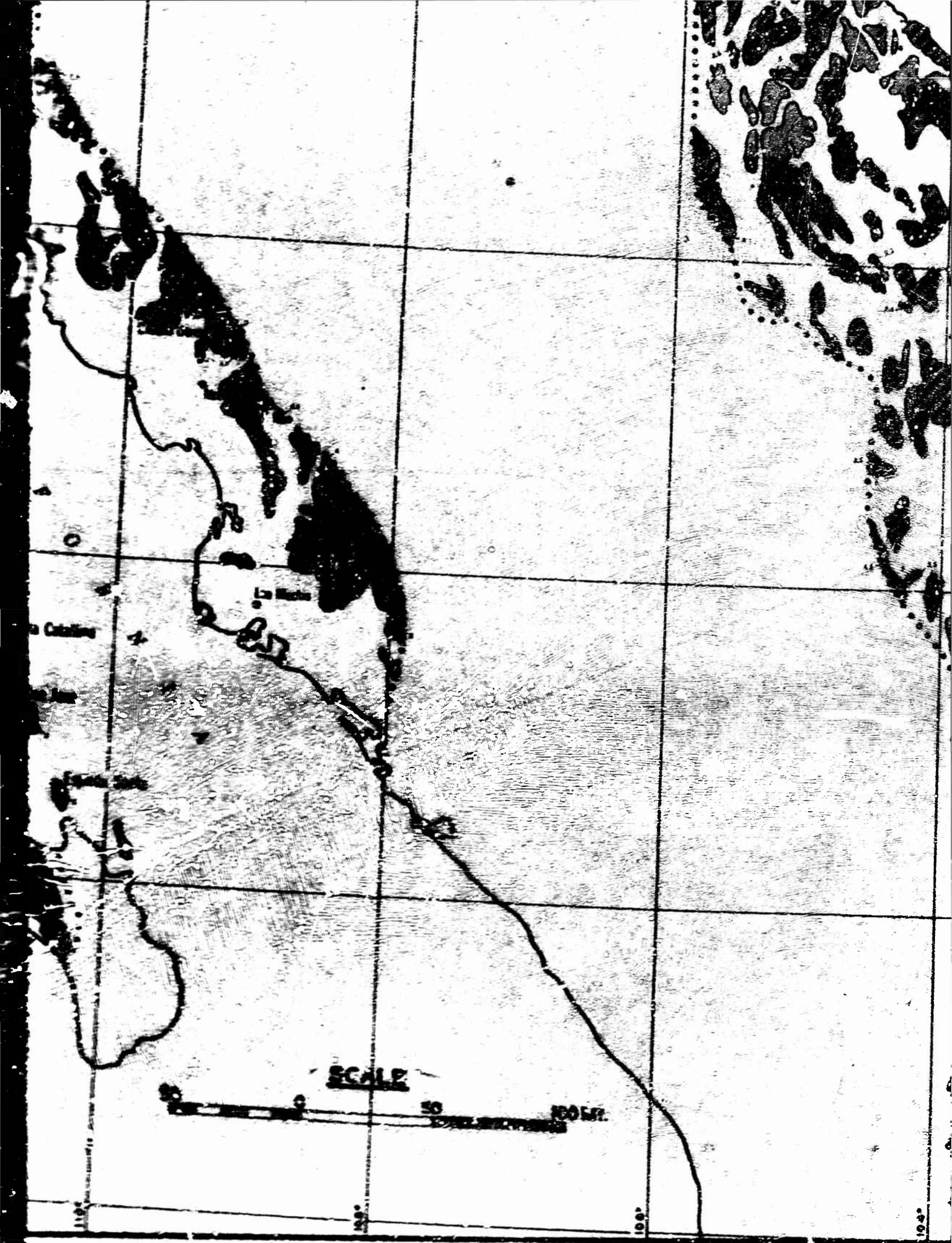
9. Evaporites: A sedimentary rock whose origin is largely due to evaporation and subsequent precipitation of salt from water. (Gypsum, anhydrite, and rock salt are the only evaporites of quantitative importance.)

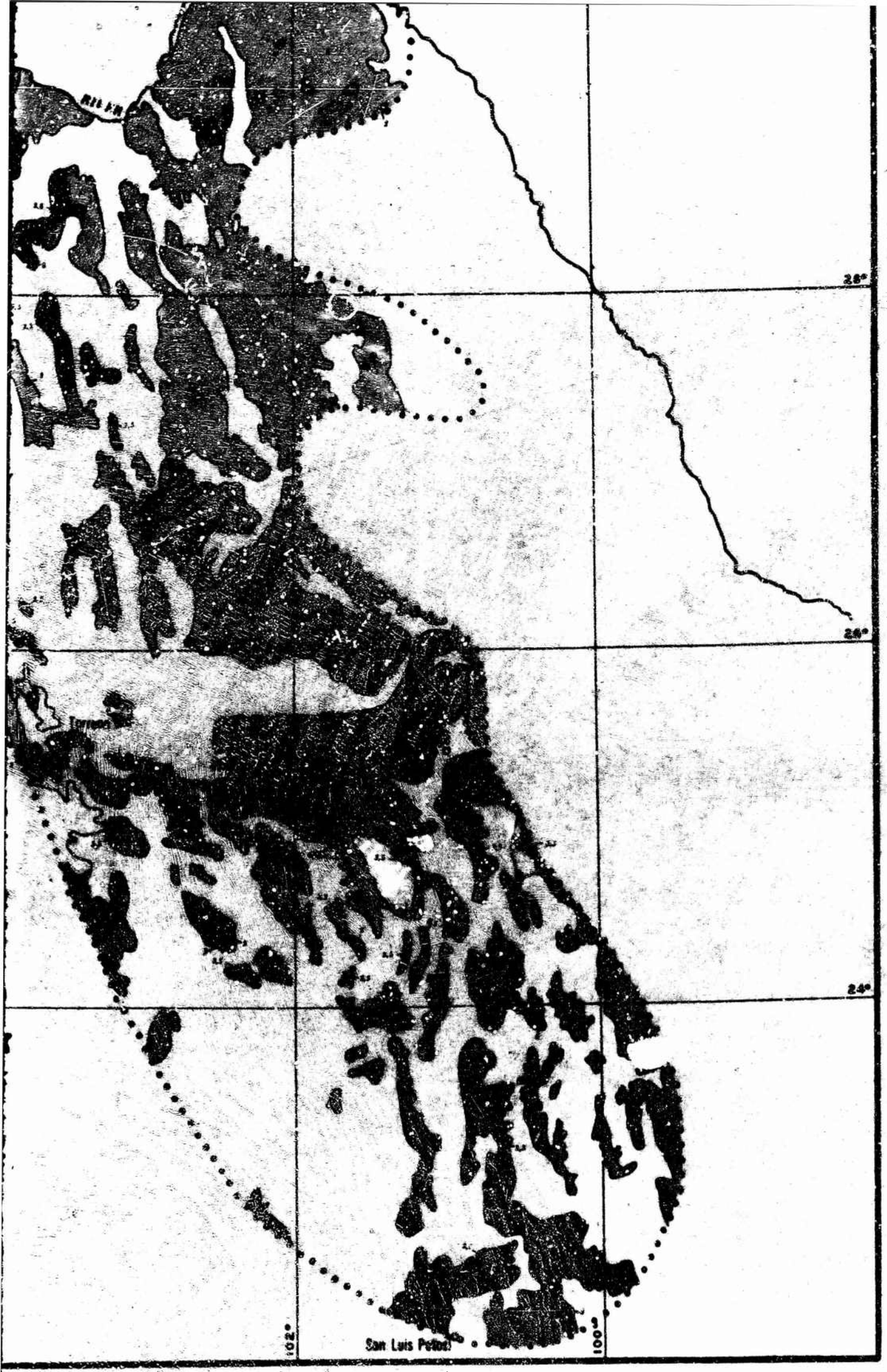
ROCK COMPLEXES: Rock complexes are mapped in areas where two dominant rock types occur, the areally predominant of these two is shown as the numerator, the areally subordinate as the denominator in the fractional pattern.

* It should be realized that the scale of mapping precludes delineation, especially in mountainous regions or many alluvial areas where the thickness of soil cover is in excess of 10 ft.

In complexes (e.g., 7/8) the first digit always refers to the areally predominant unit.




SCALE
0
50
100 Mi.


28°
26°
24°
102°
100°
San Luis Potosí

Mapped in regions where rock is exposed or at shallow depths (i.e., 0-10 feet) in comparison to the remainder of the area. In effect this procedure restricts the mapping of surface rock to areas mapped as [illegible] under Soil Types.

Areally predominant (50 per cent or more) rock type mapped.

1 IGNEOUS (UNDIFFERENTIATED): Rocks formed by solidification or crystallization of a hot fluid mass.

2 Intrusive: Igneous rocks, usually crystalline, which have formed by cooling below the surface of the earth. (Granite, syenite, diorite, etc.)

3 Extrusive (Volcanic): Igneous rocks which have formed by cooling at the surface of the earth.

3a Type 1: Igneous rocks formed by solidification of [illegible] that have flowed on the surface of the earth. (Basalt, rhyolite, etc.)

3b Type 2: Rocks formed by secondary cementation of loose debris of volcanic ejecta (e.g., tuff, agglomerate; etc.)

4 METAMORPHIC (UNDIFFERENTIATED): Rocks formed from original igneous or sedimentary rocks through alterations produced by pressure, heat, or the infiltration of other materials at depths below the surface zones of weathering and cementation. The alterations are sufficiently complete throughout the body of the rock to produce a well defined new type. (Gneiss, schist, slate, etc.)

5 SEDIMENTARY (UNDIFFERENTIATED): Rocks formed from materials laid down in a more or less finely divided state, as sediment, through the agency of water, wind, or glaciers.

6 Sandstone: A sedimentary rock predominantly composed of sand grains cemented together.

7 Limestone: A sedimentary rock consisting essentially of calcium carbonate.

8 Shale: A sedimentary rock in which the constituent particles are predominantly of clay size.

9 Evaporites: A sedimentary rock whose origin is largely due to evaporation and subsequent precipitation of salt from water. (Gypsum, anhydrite, and rock salt are the only evaporites of quantitative importance.)

ROCK COMPLEXES: Rock complexes are mapped in areas where two dominant rock types occur; the areally predominant of these two is shown as the numerator, the areally subordinate as the denominator in the fractional pattern.

* It should be realized that the scale of mapping precludes delineation, especially in mountainous regions, of many alluvial basins where the thickness of soil cover is much greater than 10 ft.

In complexes (e.g., 2/3) the first digit always refers to the areally predominant unit.

GENERALIZED ROCK PROPERTIES

Rock Type	RATINGS OF WORKING CHARACTERISTICS						SUITABILITY FOR					
	Abrasiveness	Excavational Requirements	Permeability	Stability in Steep-walled Cuts	Roof Strength in Tunnels	Loading Capacity	Compacted Subgrade	Dimension Stone	Road Metal	Bituminous Aggregate	Concrete Aggregate	Fill
	A B C D E	a b c d e	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
1. IGNEOUS												
2. Intrusive												
3. Extrusive												
1a. Solidified												
1b. Cemented												
4. METAMORPHIC												
5. SEDIMENTARY												
6. Sandstone												
7. Limestone												
8. Shale												
9. Evaporites												

Abrasiveness (as it affects excavation tools and equipment):

A. Extreme
B. Severe
C. Moderate
D. Slight
E. Nominal or none

Tools and procedures required to excavate rock:

a. Spade and shovel
b. Pick and shovel
c. Pick, crowbar, and wedge
d. Repeated drilling and blasting
e. Almost continuous drilling and blasting

All other properties:

1. Excellent
2. Good
3. Adequate or fair
4. Poor or usable only in emergencies
5. Inadequate, unsuitable or absent

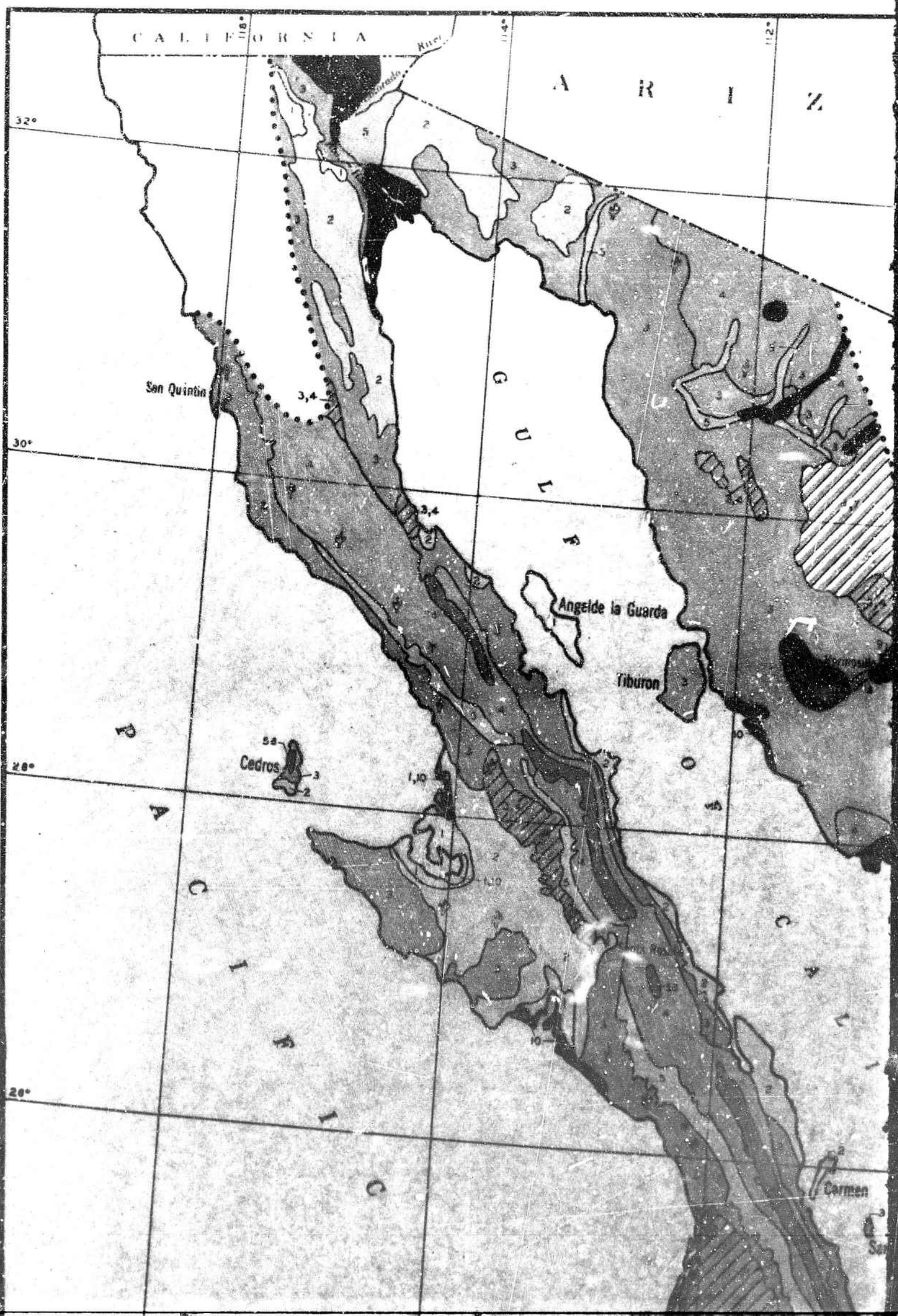
Modified from van Bolow

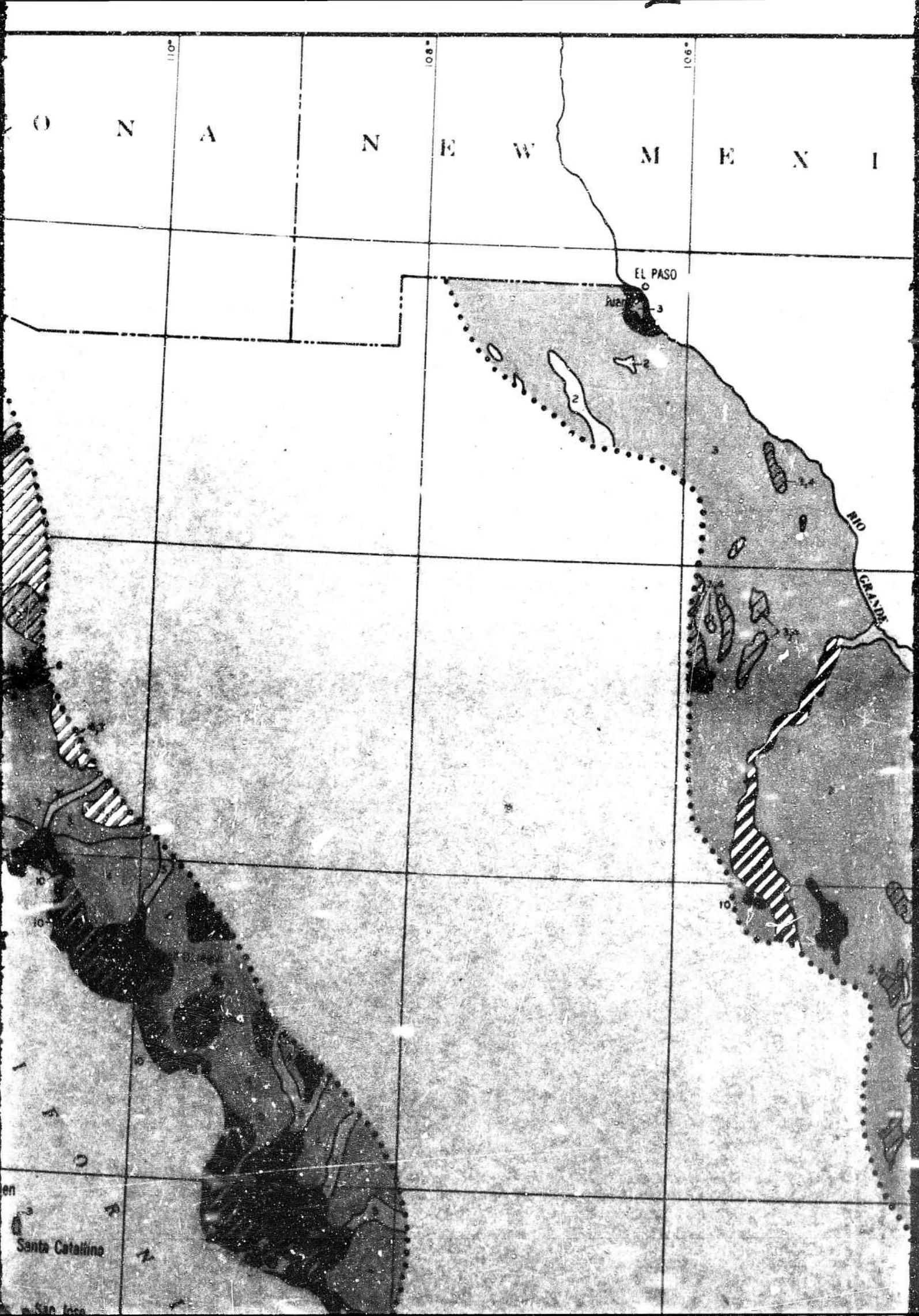
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

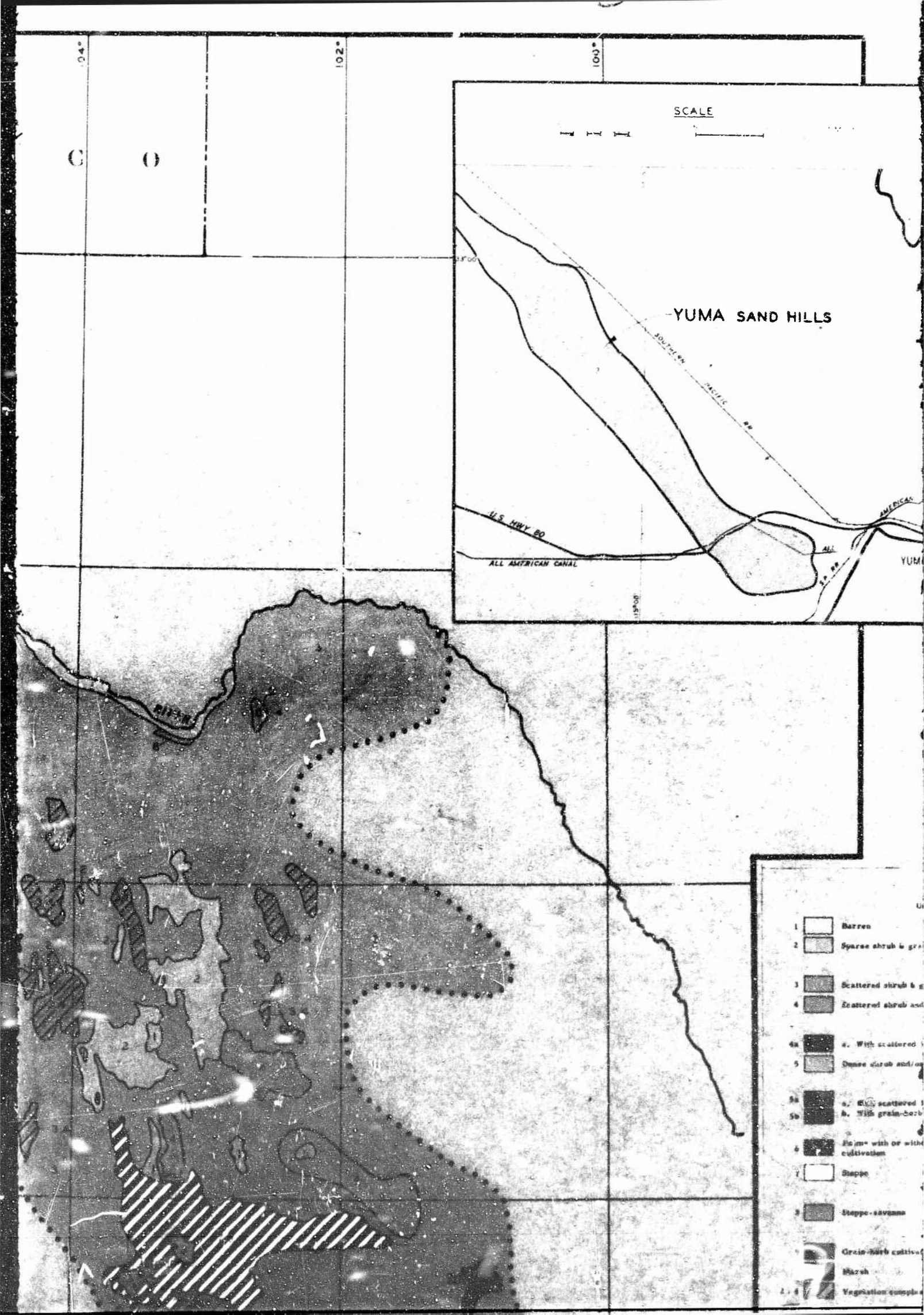
SURFACE ROCK

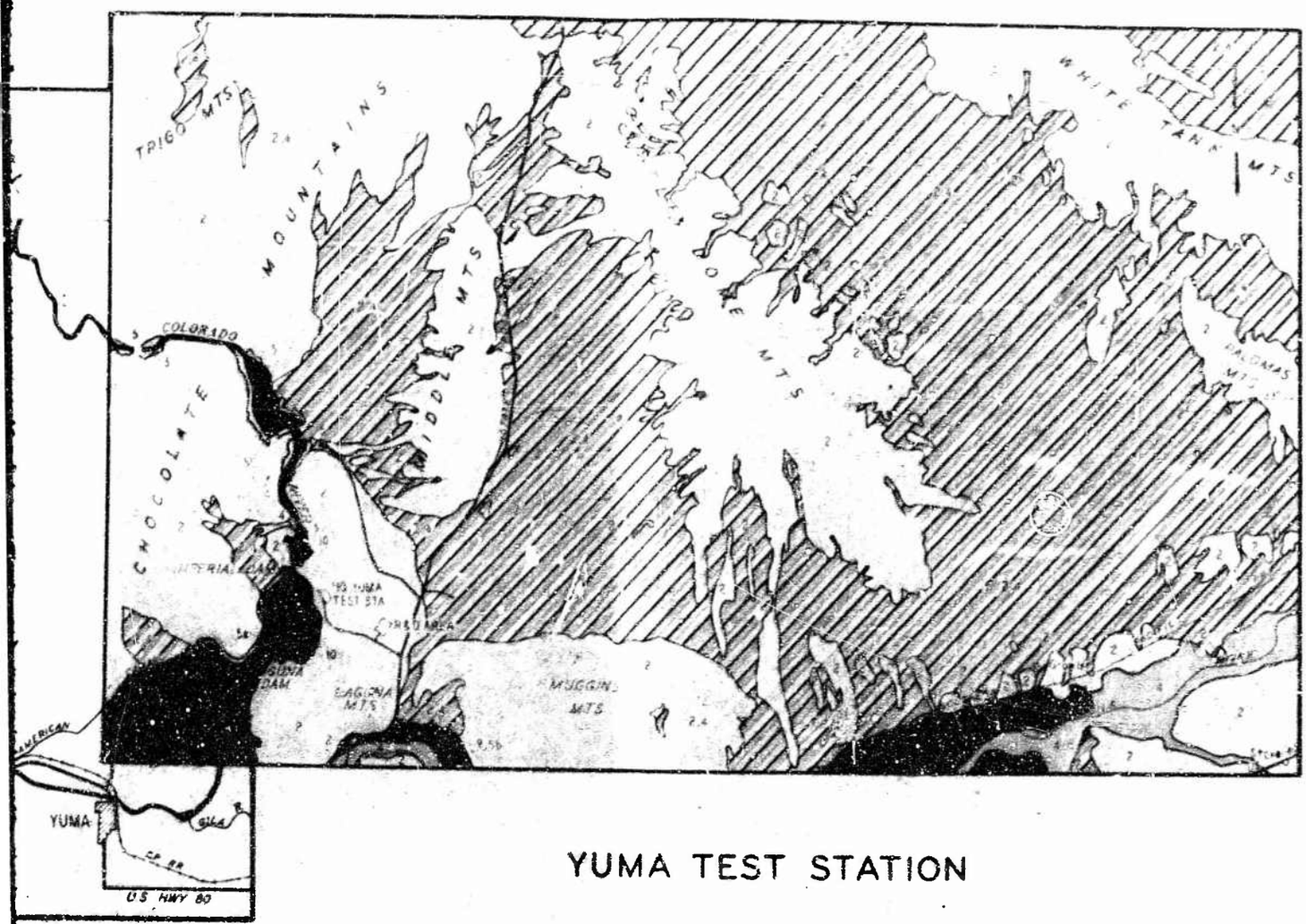
8

PLATE 8


CALIFORNIA
ARIZ
GULF
PACIFIC
San Quintin
Angelde la Guarda
Tiburon
Cedros
Carmen
32°
30°
28°
26°
114°
112°


O N A
N E W M E X I
110°
108°
106°
EL PASO
RIO GRANDE
Santa Catalina


SCALE
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
AMERICAN
YUMA
1 Barren
2 Sparse shrub & gra
3 Scattered shrub & g
4 Scattered shrub and
4a a. With scattered
5 Dense shrub and/or
5a a. With scattered
5b b. With grain-herb
6 Farms with or with
cultivation
7 Steppe
8 Steppe-savanna
Grain-herb cultiva
Marsh
Vegetation complex



YUMA TEST STATION

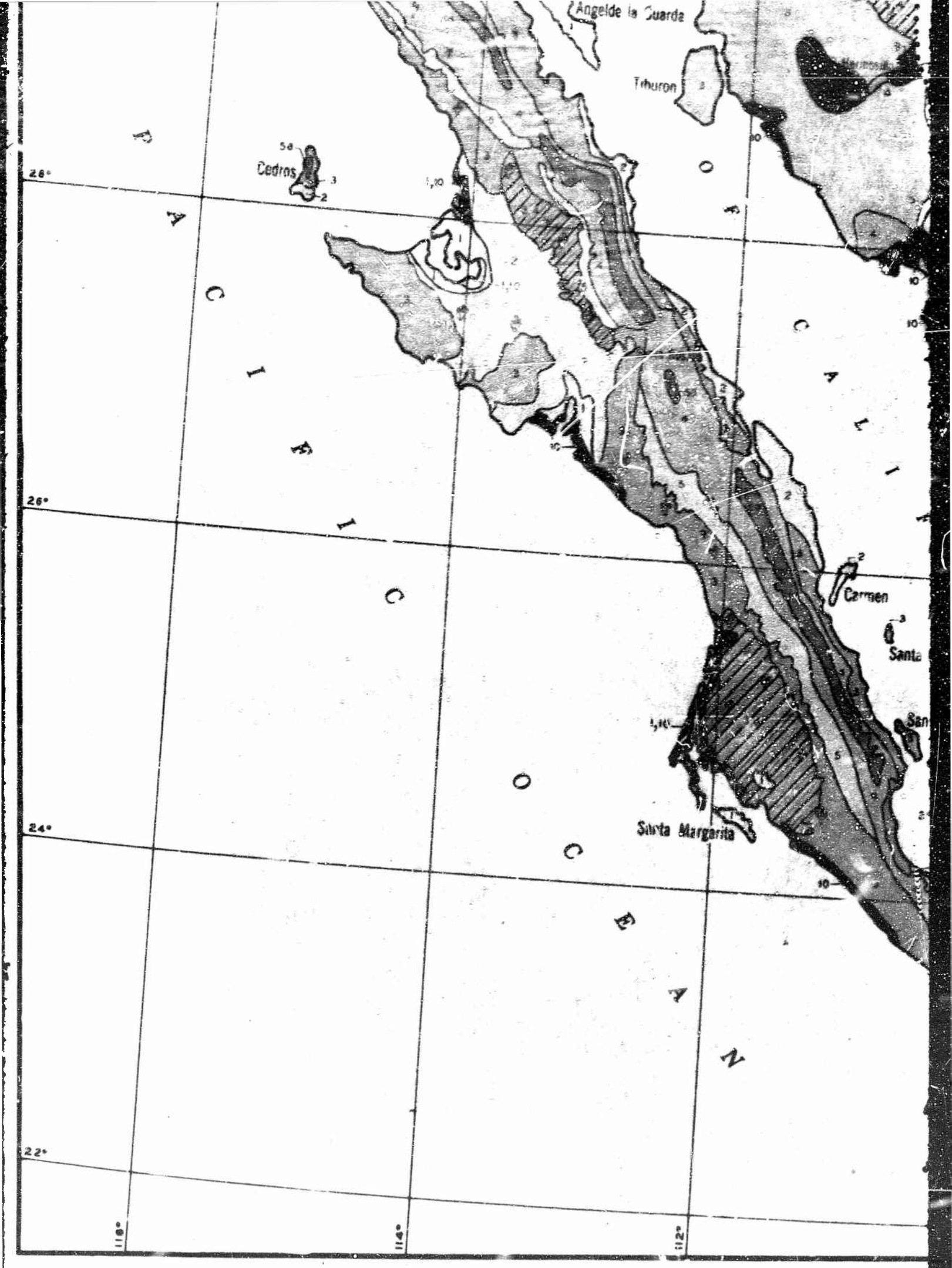
VEGETATION

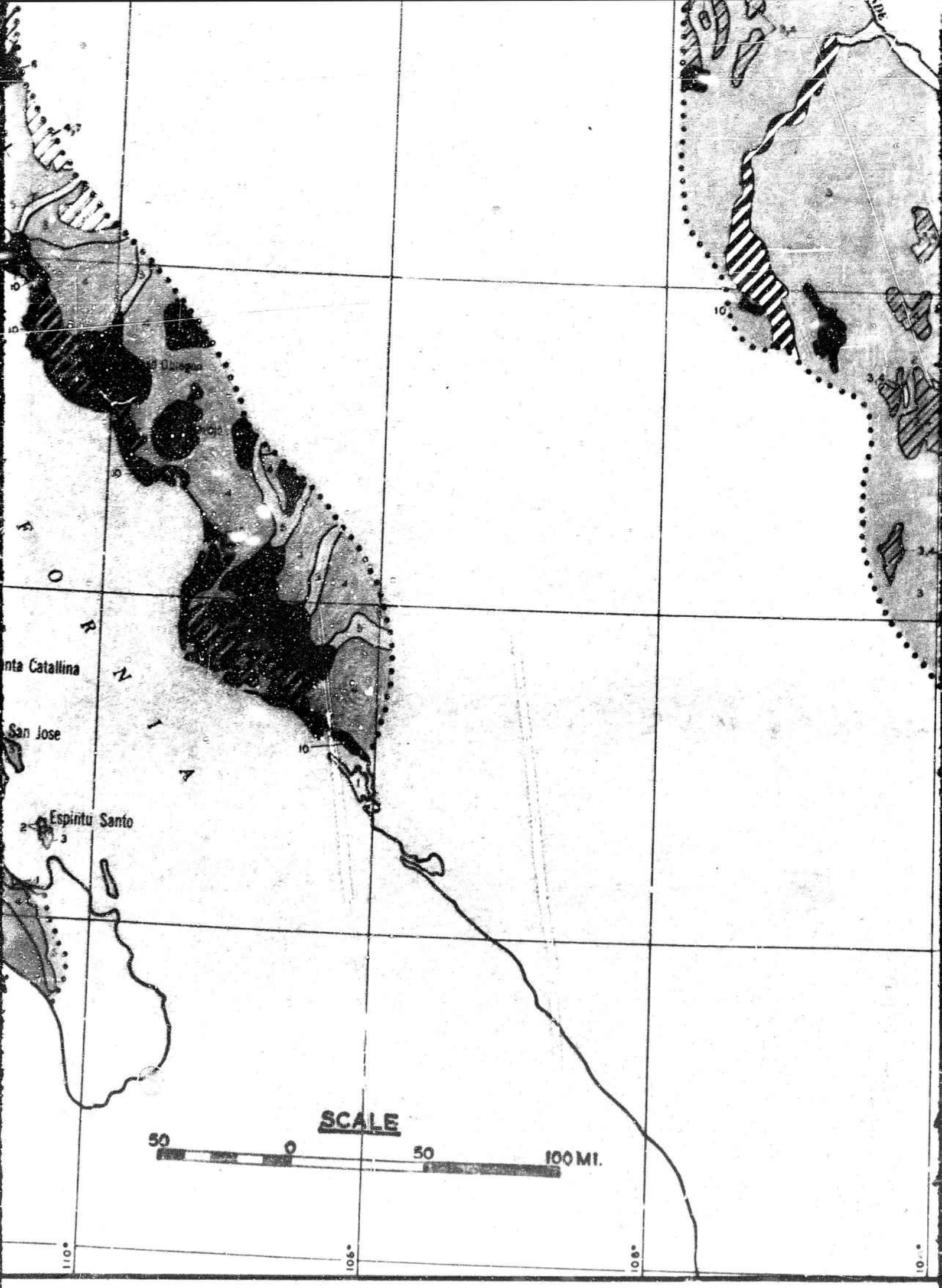
Unit	Description
	Devoid or nearly devoid of vegetation
ub & grass	Widely spaced thorny shrubs, bushes, low scrubby trees, herbs, or clumps and open stands of coarse grass. (Also includes cacti in the U. S.)
shrub & grass	Moderate spacing of forms mentioned under unit 2.
shrub and/or scrubby trees	Thin stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
attered 3rd story trees	.....
ub and/or scrubby trees	Dense stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes and grasses.
attered 3rd story trees rain-herb cultivation	..... Orchard areas with grain-herb cultivation forming the 1st story.
or without grain-herb	Dense palm groves, 1st story grain-herb cultivation may or may not be present.
	Low grass cover, may or may not include scattered low scrubby trees and shrubs. Height of grass ranges from a few in. to 2 ft.
rass	High continuous grass cover, includes scattered scrubby trees and shrubs. Height of grass average 3-5 ft.
cultivated	Cultivated plots of grains, vegetables, etc.
	Dense growth of grasses, sedges, etc.
complexes	Vegetation complexes are mapped where no single predominant vegetation type is present, as such the

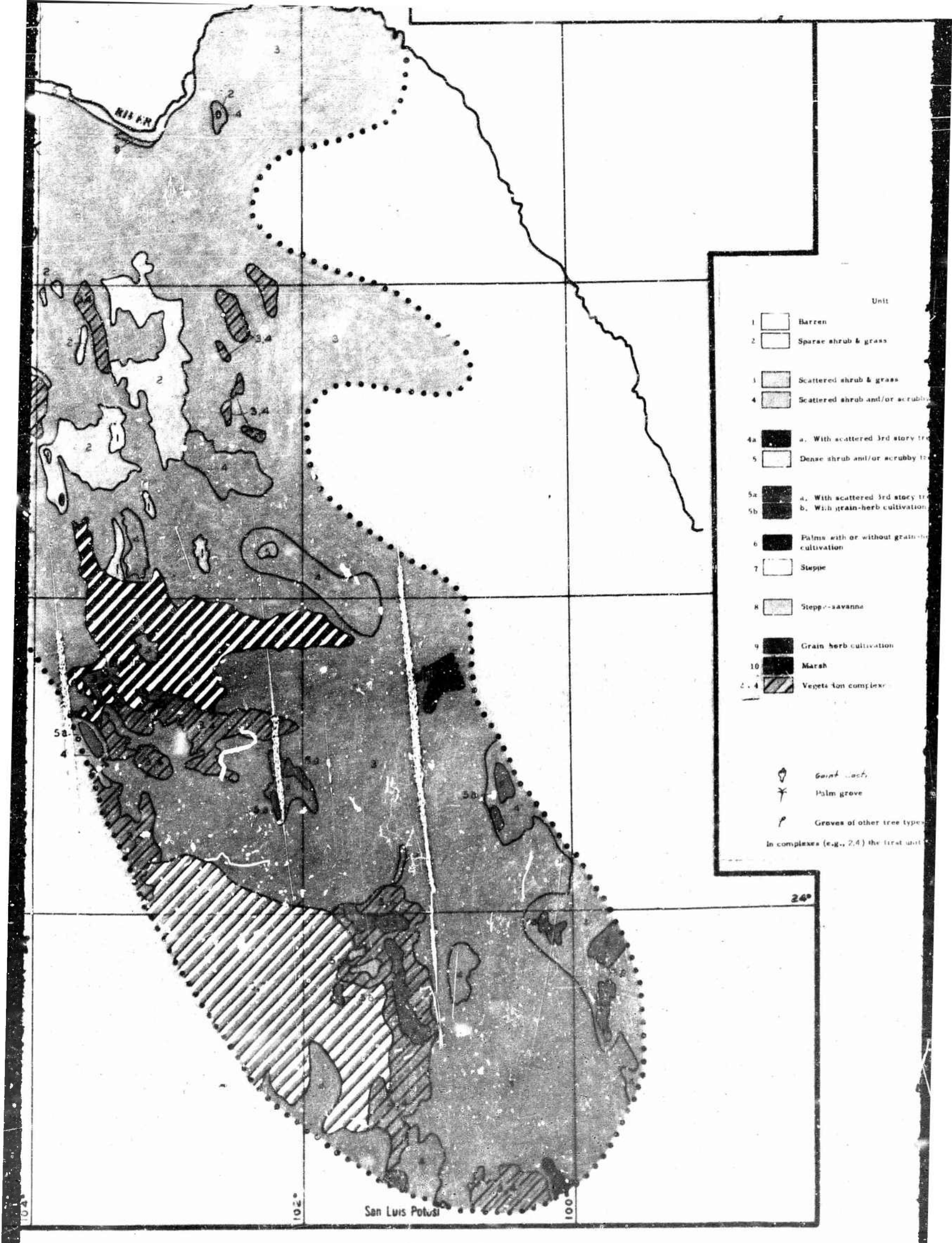
VEGETATION

(Supplementary Data)

Unit	Ground Cover %	Canopy Cover 2nd Story %	Canopy Cover 3rd Story %	Spacing 2nd Story ft	Spacing 3rd Story ft	Height 2nd Story ft	Height 3rd Story ft	Trunk Dia 2nd Story in.	Trunk Dia 3rd Story in	Crown Dia 2nd Story ft	Crown Dia 3rd Story ft
1. Barren	<1	0	0	0	0	0	0	0	0	0	0
2. Sparse shrub & grass	1-5	1	0	1	0	0	0	0	0	0	0
3. Scattered shrub & grass	5-25	0-5	0	much >12	0	6-10	0	2-5	0	5-10	0
4. Scattered shrub and/or scrubby trees	50-90	<50	0	>12	0	6-25	0	2-12	0	5-25	0
a. With scattered 3rd story trees	50-90	<45	5-25	>12	>12	6-25	25-50	2-12	12-24	5-	25-40
5. Dense shrub and/or scrubby trees	80-100	>50	0	<12	0	6-25	0	2-12	0	5-25	0
a. With scattered 3rd story trees	80-100	>50	5-25	<12	>12	6-25	25-50	2-12	12-24	5-25	25-40
b. With grain-herb cultivation	-100	>50	0	>12	0	10-20	0	5-10	0	10-20	0
6. Palms with or without grain-herb cultivation	75-100	0	50-75	0	>12	0	40-80	0	2-24	0	20-50


Angel de la Guarda
Tiburon
Cedros
28°
26°
24°
22°
Carmen
Santa
San
Santa Margarita
PACIFICO
OCEANO
CALIFORNIA
114°
112°


nta Catallina
San Jose
Espiritu Santo
SCALE
50
0
50
100 MI.
110°
106°
105°


Unit
1 Barren
2 Sparse shrub & grass
3 Scattered shrub & grass
4 Scattered shrub and/or scrubby
4a a. With scattered 3rd story tr
5 Dense shrub and/or scrubby tr
5a a. With scattered 3rd story tr
5b b. With grain-herb cultivation
6 Palms with or without grain-h cultivation
7 Steppe
8 Steppe-savanna
9 Grain-herb cultivation
10 Marsh
2, 4 Vegetation complexe
Gallery forest
Palm grove
Groves of other tree types
In complexes (e.g., 2,4) the first unit
Rio Pánuco
San Luis Potosí
24°
104°
102°
100°

VEGETATION

Description

Devoid or nearly devoid of vegetation

Widely spaced thorny shrubs, bushes, low scrubby trees, herbs, or clumps and open stands of coarse grass. (Also includes cacti in the U. S.)

Moderate spacing of forms mentioned under unit .

Thin stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.

Dense stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.

Orchard areas with grain-herb coltivation forming the 1st story.

Dense palm groves, 1st story grain-herb cultivation may or may not be present.

Low grass cover, may or may not include scattered low scrubby trees and shrubs. Height of grass ranges from a few in. to 2 ft.

High continuous grass cover, includes scattered scrubby trees and shrubs. Height of grass averages 2-5 ft.

Cultivated plots of grains, vegetables, etc.

Dense growth of grasses, sedges, etc.

Vegetation complexes are mapped where no areally predominant vegetation type occurs. In such instances, the two most commonly occuring types are mapped; the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

...ee types

...rst unit always refers to the areally predominant unit.

VEGETATION

(Supplementary Data)

Unit	Ground Cover %	Canopy Cover		Spacing		Height		Trunk Dia.		Crown Dia.	
		†2nd Story %	3rd Story %	2nd Story ft	3rd Story ft	2nd Story ft	3rd Story ft	2nd Story in.	3rd Story in.	2nd Story ft	3rd Story ft
1. Barren	<1	*	*	*	*	*	*	*	*	*	*
2. Sparse shrub & grass	1-5	*	*	*	*	*	*	*	*	*	*
3. Scattered shrub & grass	5-25	0-5	*	much >12	*	6-10	*	2-5	*	5-...	*
4. Scattered shrub and/or scrubby trees	50-90	<50	*	>12	*	6-25	*	2-12	*	...-...	*
a. With scattered 2ro story trees	50-90	<45	5-25	>12	>12	6-25	25-50	2-12	12-24	...-...	...-... *
5. Dense shrub and/or scrubby trees	80-100	>50	*	...12	*	6-25	*	2-12	*	...-...	*
a. With scattered 3rd story trees	80-100	>50	5-25	>12	>12	6-25	25-50	2-12	12-24	...-...	...-... *
b. With grain-herb cultivation	90-100	>50	*	...12	*	10-20	*	5-10	*	...-...	*
6. Palms with or without grain-herb cultivation	75-100	*	50-75	*	>12	*	40-60	*	12-24	...	...-...
7. Steppe	50-100	*	*	*	*	*	*	*	*	*	*
8. Steppe-savanna	90-100	5-10	*	much >12	*	15-25	*	7-12	*	15-25	*
9. Grain-herb cultivation	90-100	*	*	*	*	*	*	*	*	*	*
10. Marsh	80-100	*	*	*	*	*	*	*	*	*	*

† Vegetation stories are distinguished on the basis of height: 1st story vegetation ranges from 0 to 6 ft in height; 2nd story, from 6 to 25 ft; 3rd story, from 25 to 70 ft.

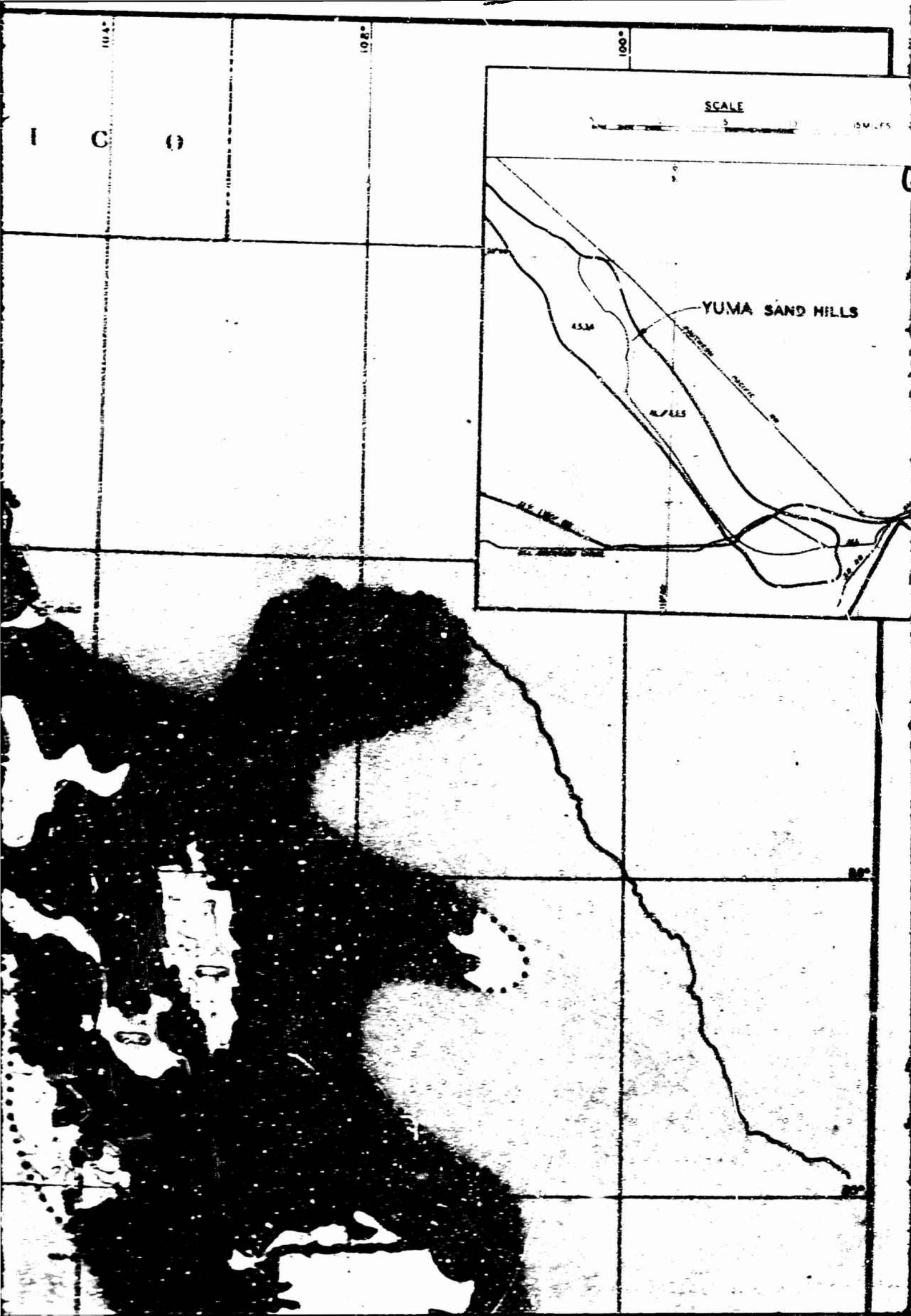
* Indicates factor is unimportant or not applicable within the vegetation unit.

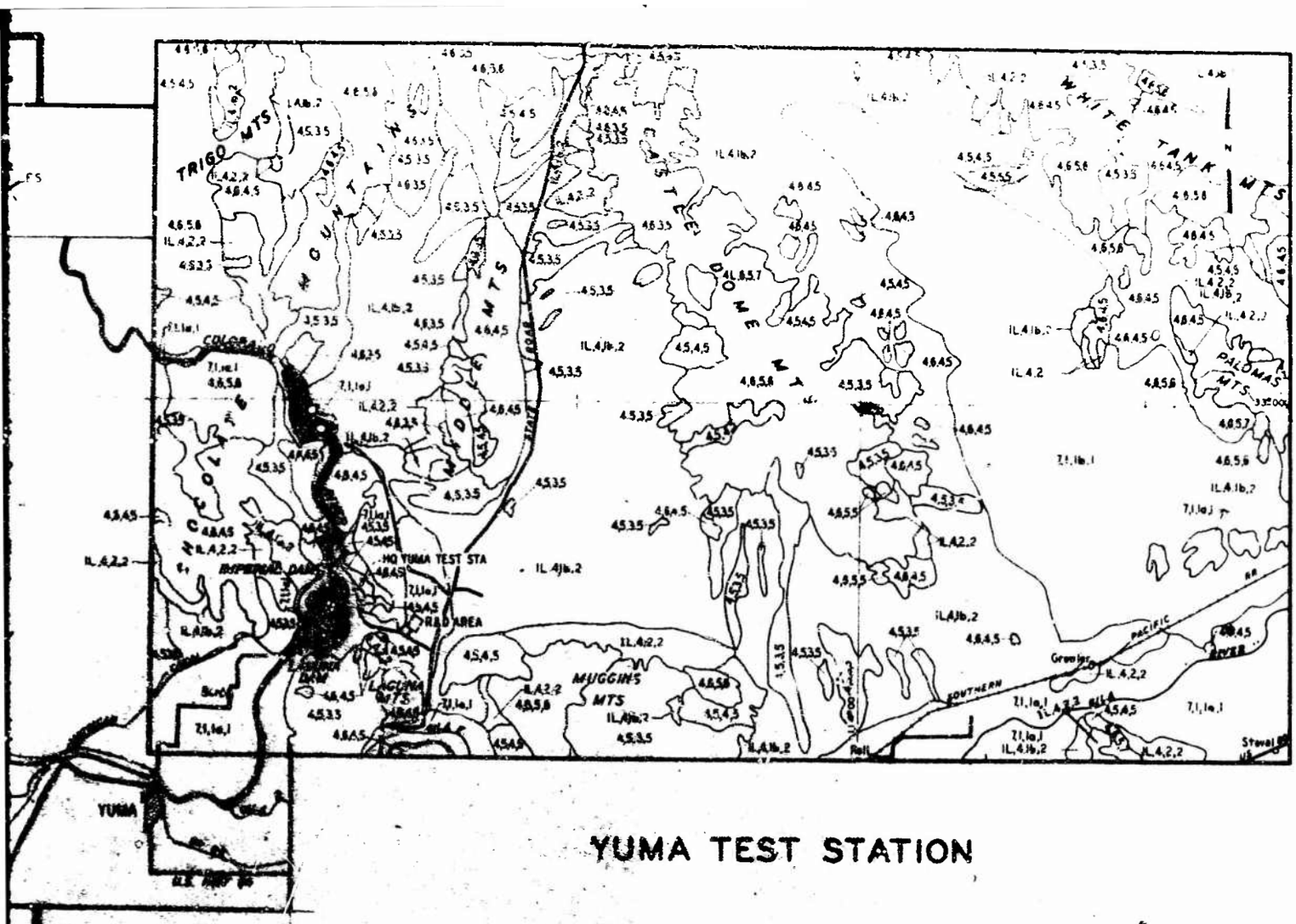
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

VEGETATION

8

PLATE 9


SCALE
YUMA SAND HILLS



YUMA TEST STATION

CHARACTER OF YUMA ANALOGUE

LEGEND

4,5,3,5 Identifies landscape type: (4) characteristic plan-profile, (5) slope occurrence, (3) slope, and (5) relief.

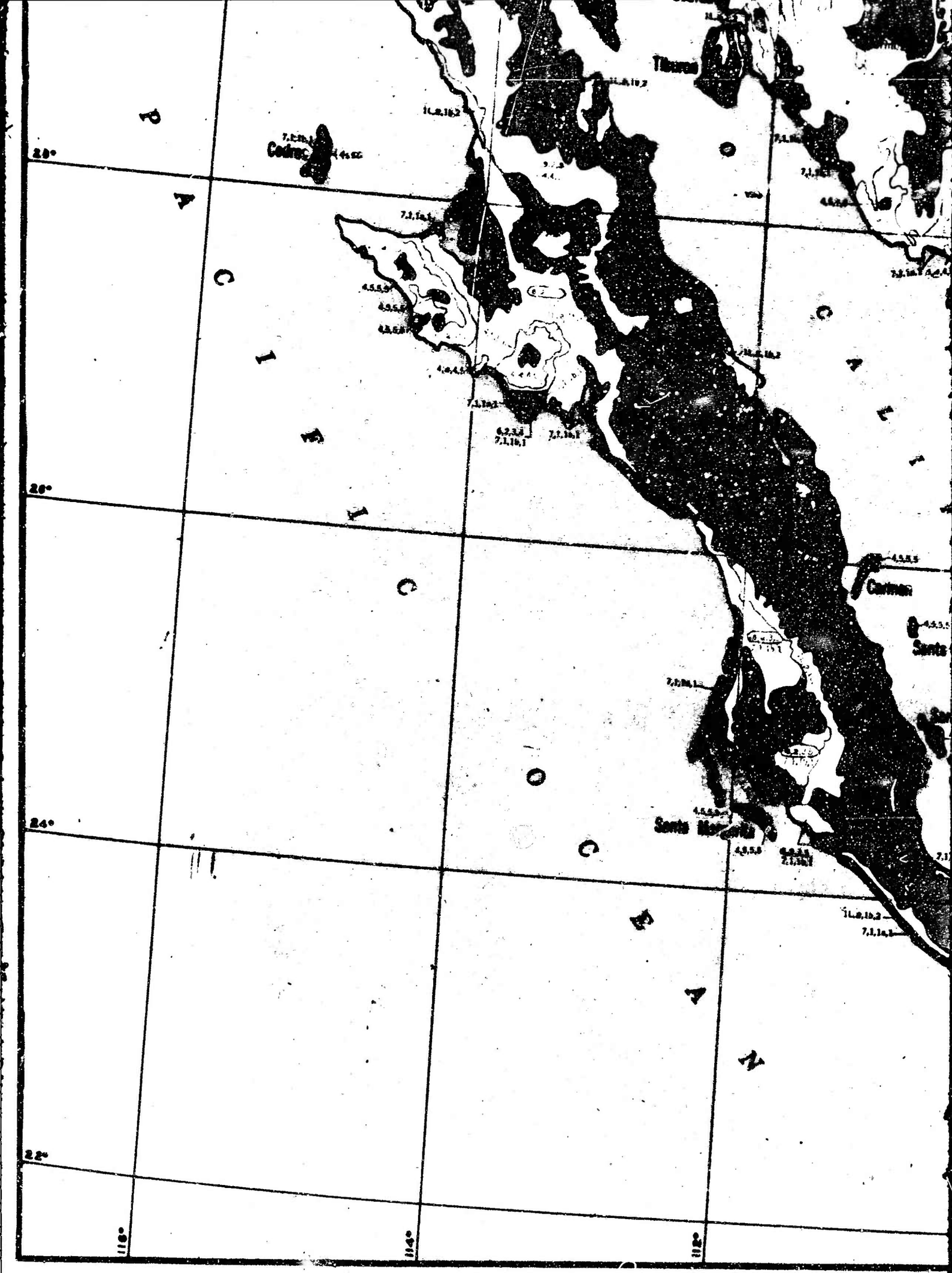
7,1,1a,1 Subscript numbers indicate that these units are found in combination at Yuma. If all four numbers are highlighted, e.g., **IL,4,2,2** the landscape type is found at Yuma. Boldface numbers indicate that these units are not found in combination at Yuma.

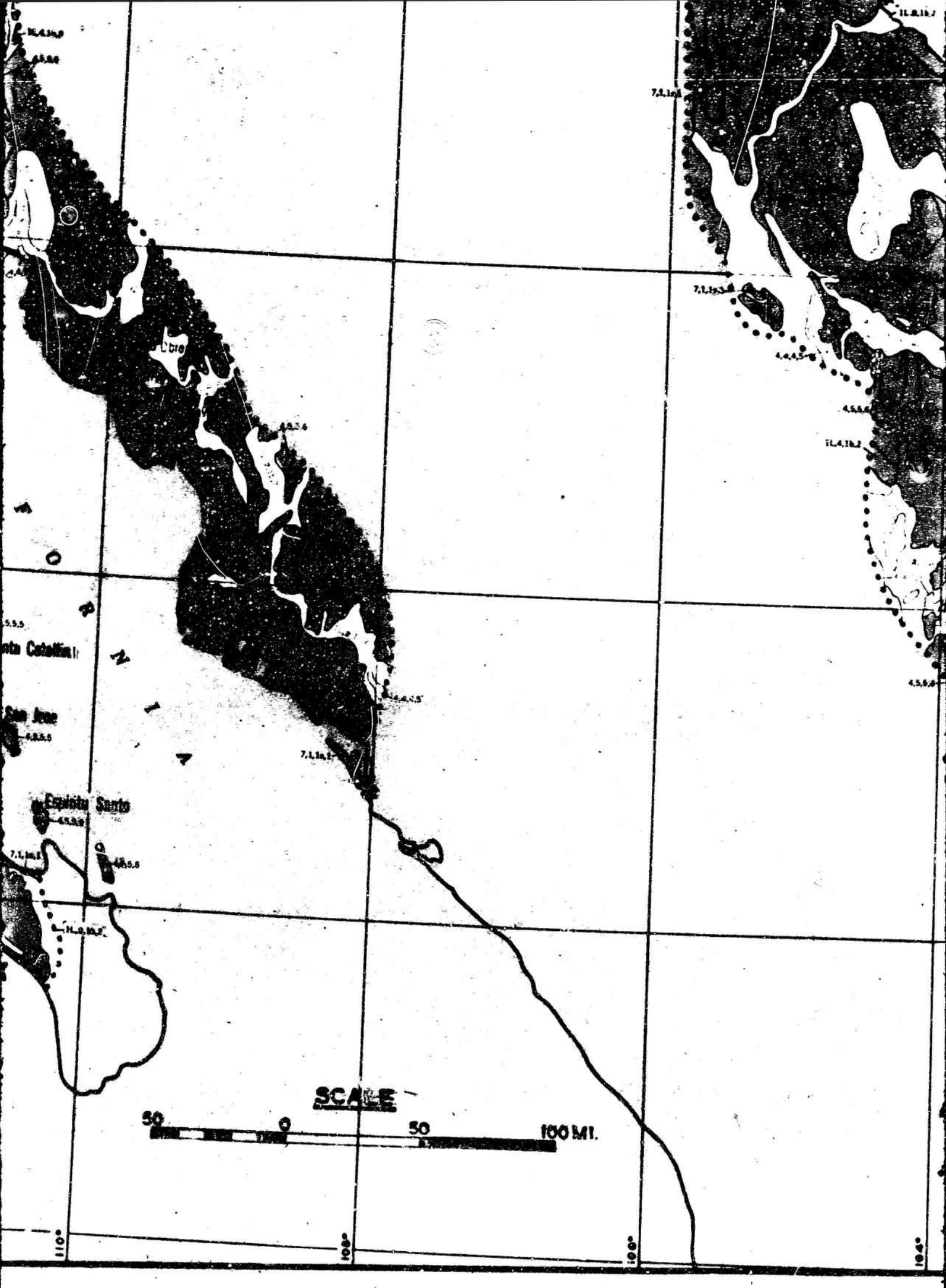
COMPLEXES

Three-component complex, the green landscape is circled.

Ideal complex.

4	Highly Analogous	Landscape type found at Yuma. In areas of complexes, both of landscape types are found at Yuma.
3	Moderately Analogous	Three out of four units found in combination at Yuma. In areas of complexes, five to seven of the possible eight units are found in combination at Yuma.
2-3	Slightly Analogous	One or two out of four units found in combination at Yuma. In areas of complexes, two to four of the possible eight units are found in combination at Yuma.
1	Not Analogous	None of the four units are found at Yuma. In areas of complexes, one or more of the possible eight units is found at Yuma.


Tiburon
Cedros
Carmen
Santa Margarita
28°
26°
24°
22°
114°
112°


Cabo
Santa Catalina
San Jose
Espiritu Santo
SCALE
50 0 50 100 MI.
110°
108°
106°
104°

San Luis Potosí
102°
100°

GEOMETRY OR FORM ANALOGS

LEGEND

4,5,3,5 Identifies landscape type: (4) characteristic plan-profile, (5) slope occurrence, (3) slope, and (5) relief.

7,1,8,8 Lightface numbers indicate that these units are found in combination at Yuma. If all four numbers are lightface, e.g., 1,8,2,2, the landscape type is found at Yuma. Boldface numbers indicate that these units are not found in combination at Yuma.

COMPLEXES:

Gross-component complex, the gross landscape is circled.

Areal complex.

4	Highly Analogous	Landscape type found at Yuma. In areas of complexes, both of landscape types are found at Yuma.
3	Moderately Analogous	Three out of four units found in combination at Yuma. In areas of complexes, five to seven of the possible eight units are found in combination at Yuma.
1,3	Slightly Analogous	One or two out of four units found in combination at Yuma. In areas of complexes, two to four of the possible eight units are found in combination at Yuma.
0	Not Analogous	None of the four units are found at Yuma. In areas of complexes, one or more of the possible eight units is found at Yuma.

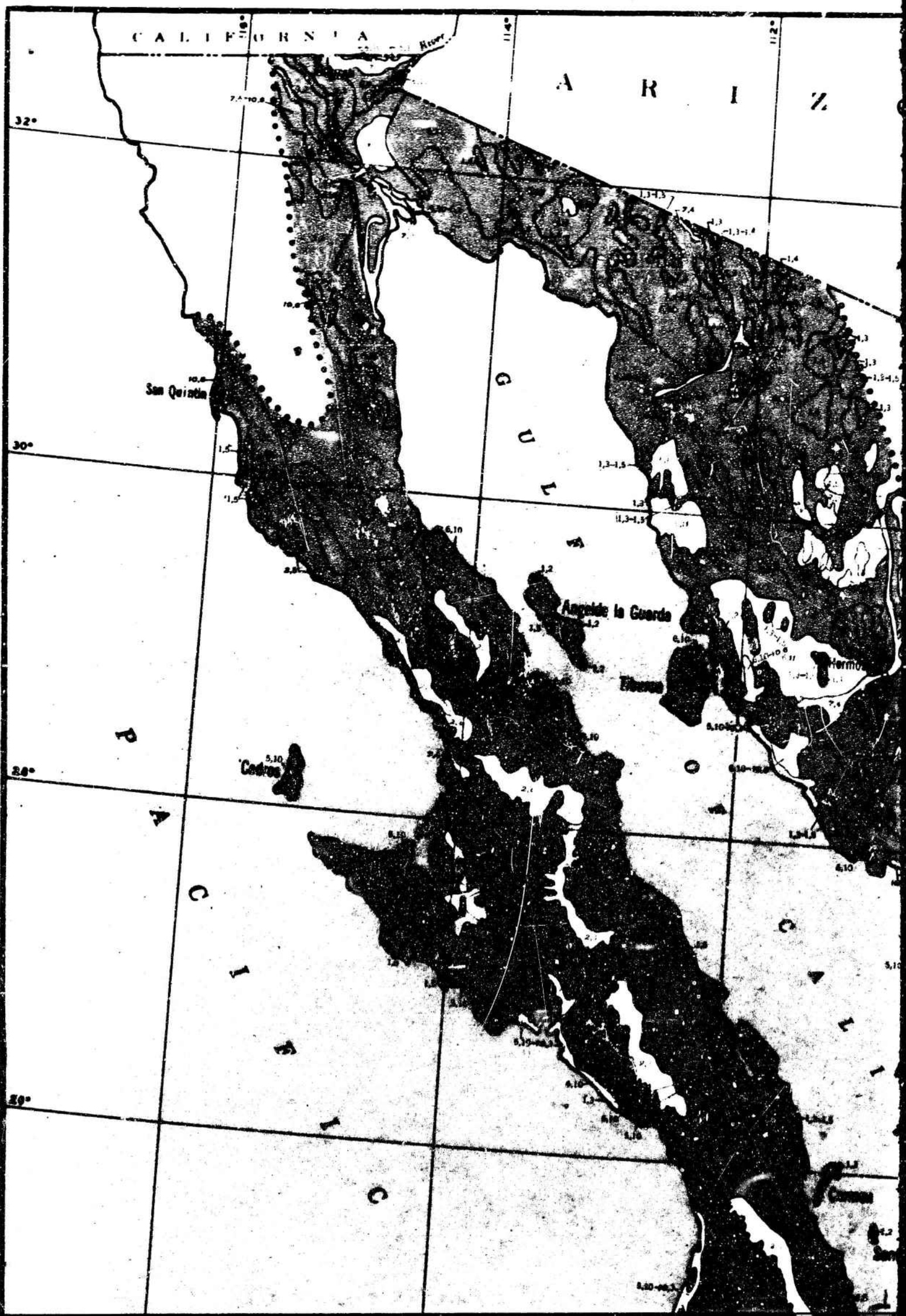
Values assigned components in compiling the Composite Analog Map.

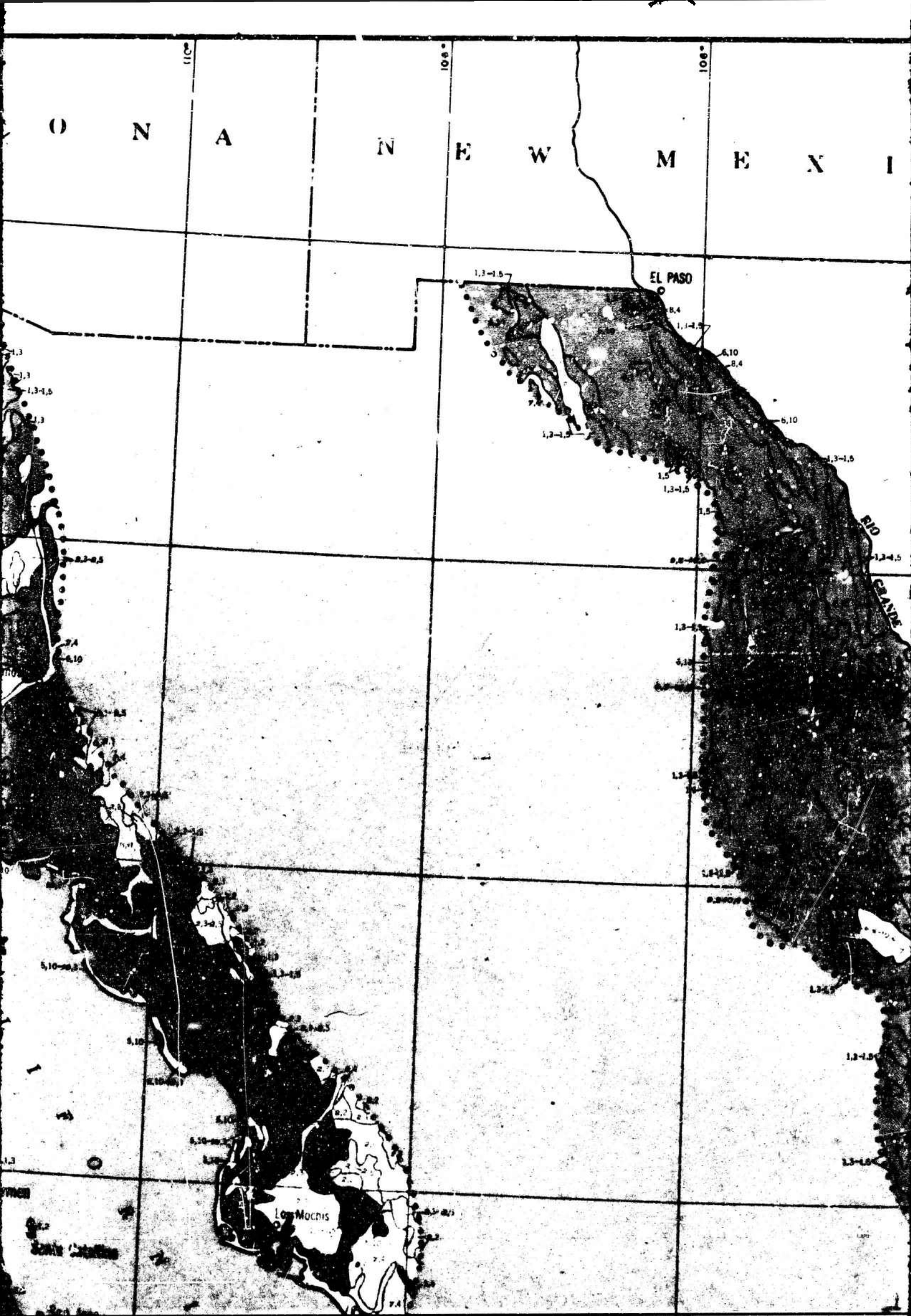
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

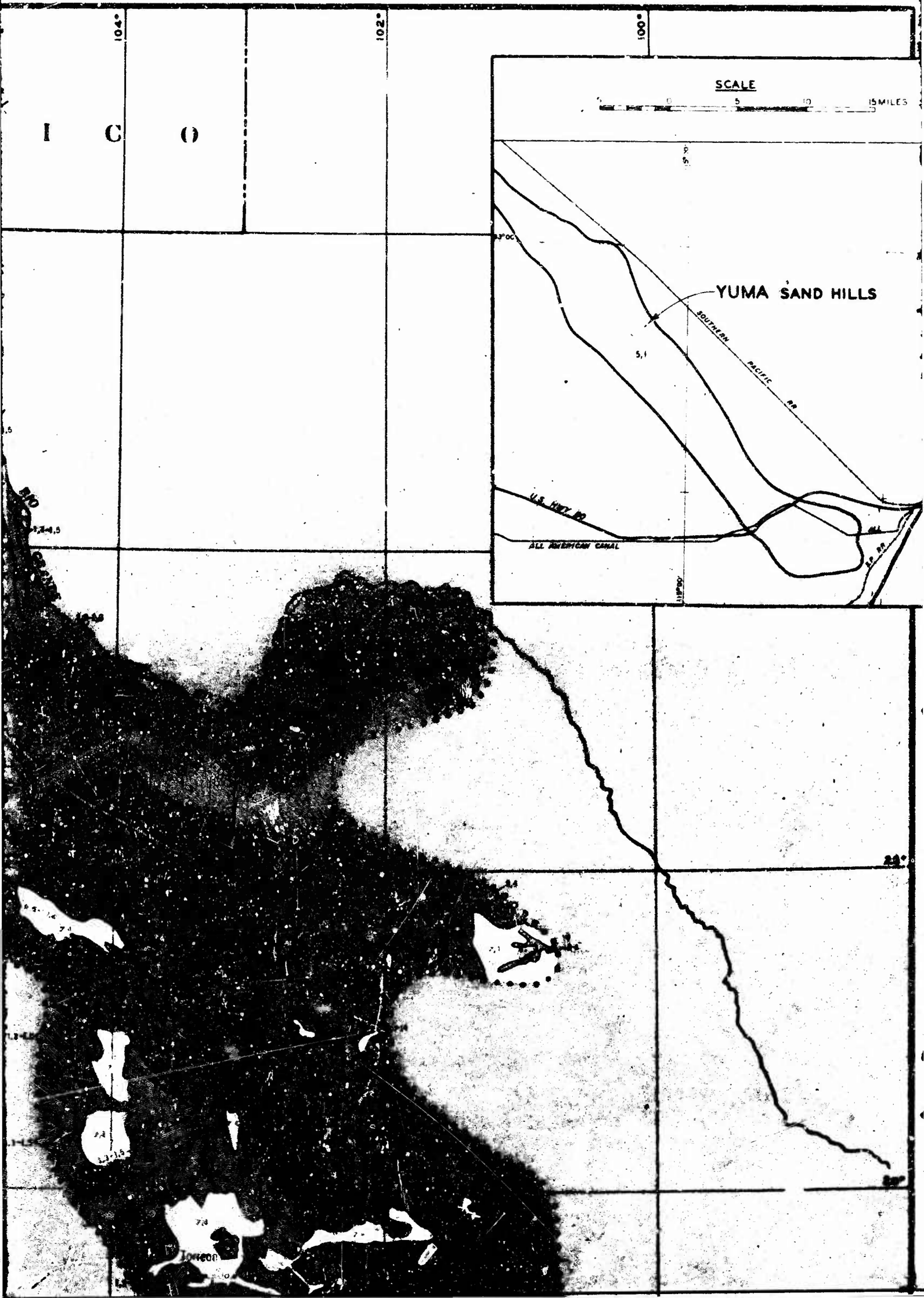
GEOMETRY ANALOGS

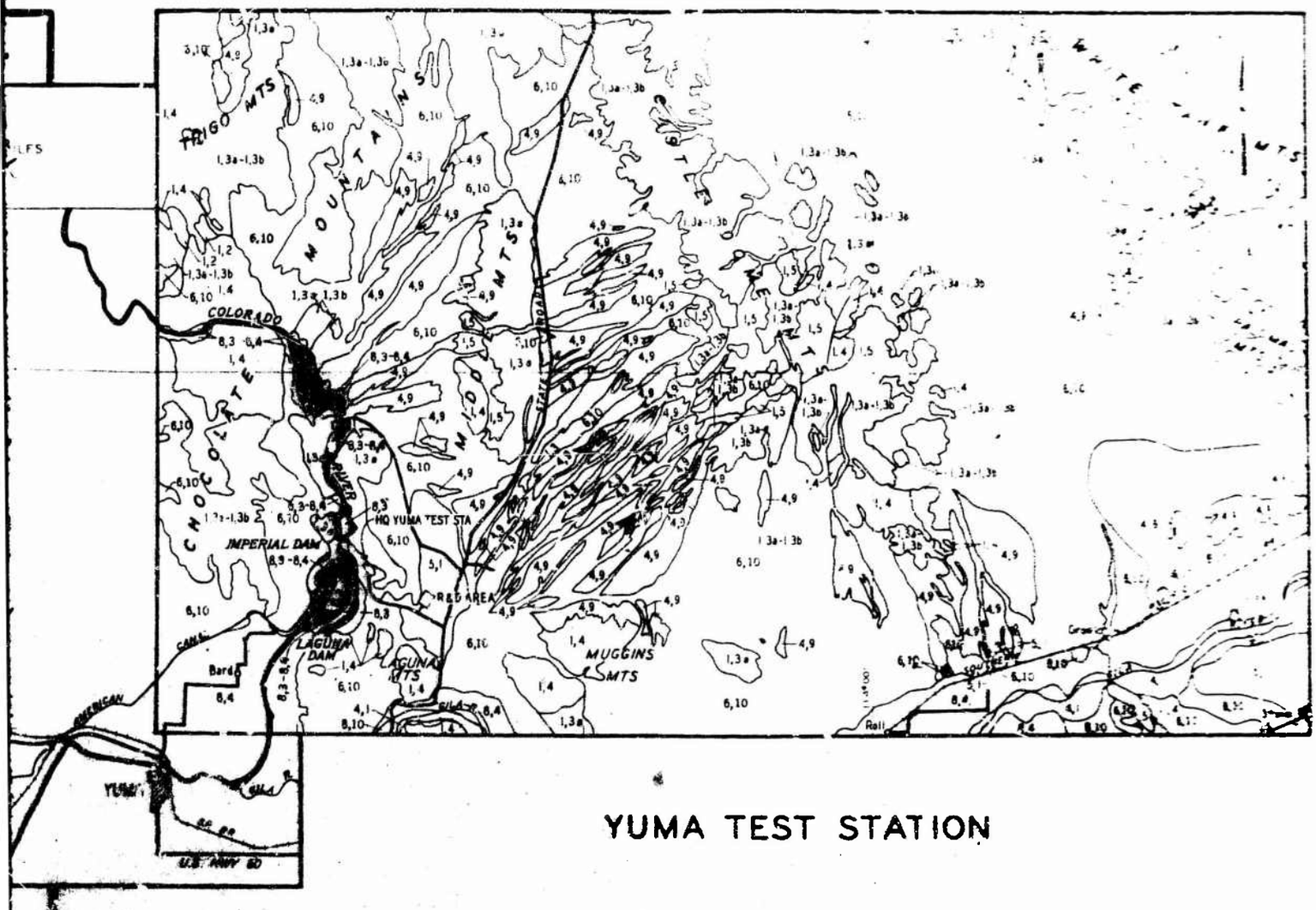
8

PLATE 17


CALIFORNIA
ARIZ
GULF OF
PACIFIC
32°
30°
28°
29°
San Quintin
Angel de la Guarda
Cedros


ONA
NEW MEXI
EL PASO
RIO GRANDE
Los Mochis


104°
102°
100°
I C O
SCALE
0 5 10 15 MILES
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
5,1
32°00'
114°00'
Tucson



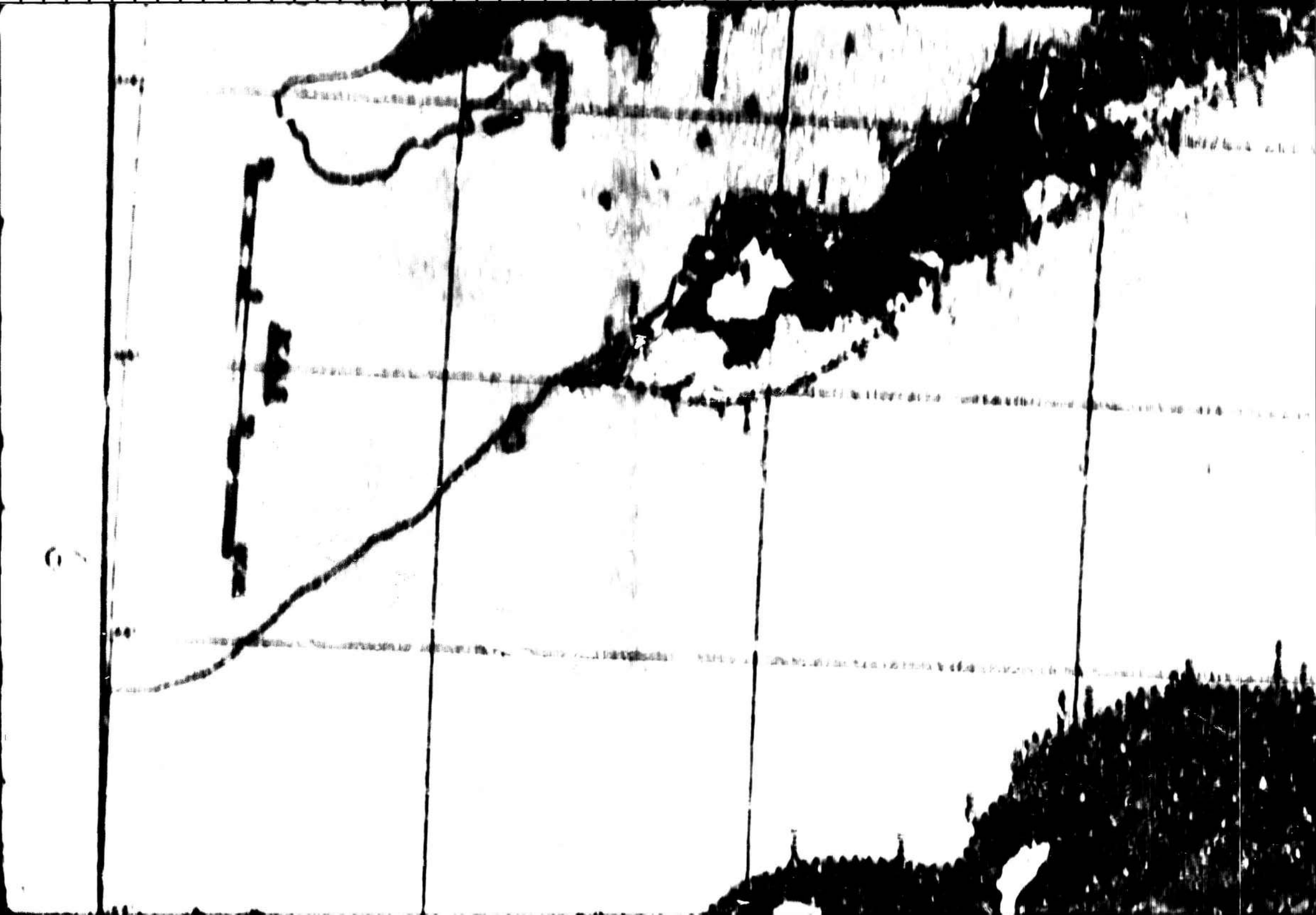
YUMA TEST STATION

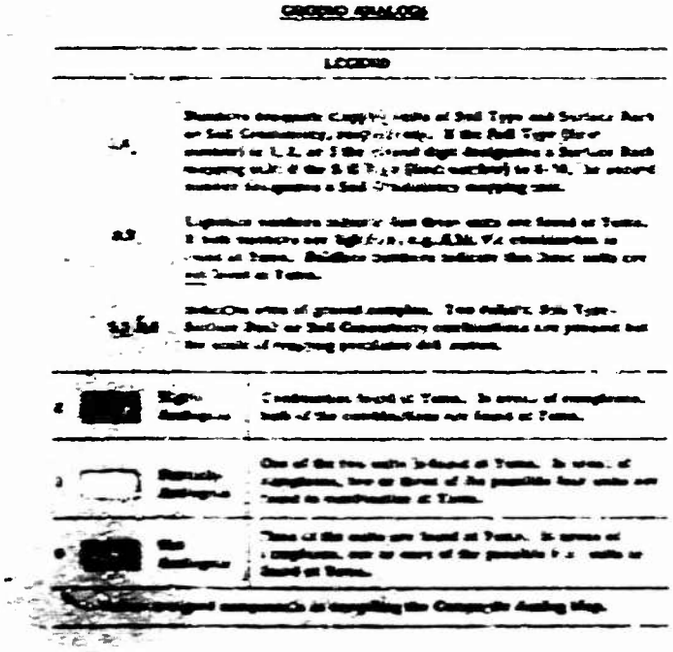
GROUND ANALOGS

LEGEND

1,4	Numbers designate mapping units of Soil Type and Surface Rock or Soil Consistency, respectively. If the Soil Type (first number) is 1, 2, or 3 the second digit designates a Surface Rock mapping unit; if the Soil Type (first number) is 4-10, the second number designates a Soil Consistency mapping unit.
8,9	Lightface numbers indicate that these units are found at Yuma. If both numbers are lightface, e.g., 8,10, the combination is found at Yuma. Boldface numbers indicate that these units are not found at Yuma.
5,1 | 8,4	Indicates area of ground complex. Two definite Soil Type-Surface Rock or Soil Consistency combinations are present but the scale of mapping precludes delineation.

2	Highly Analogous	Combination found at Yuma. In areas of complexes, both of the combinations are found at Yuma.
1	Partially Analogous	One of the two units is found at Yuma. In areas of complexes, two to three of the possible four units are found in combination at Yuma.
0	Not	None of the units are found at Yuma. In areas of





GROUND ANALOGS

LOCATION

ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

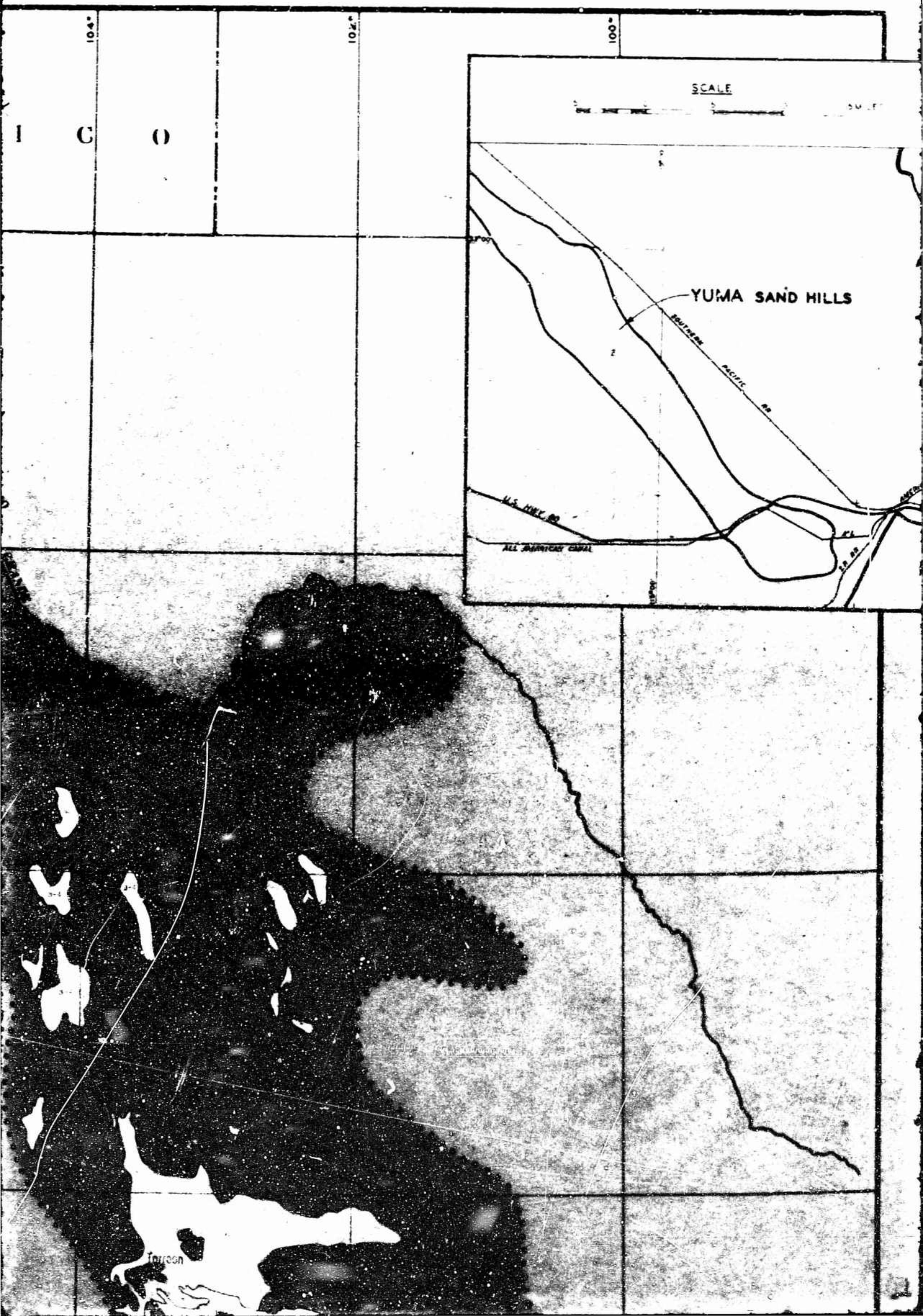
B

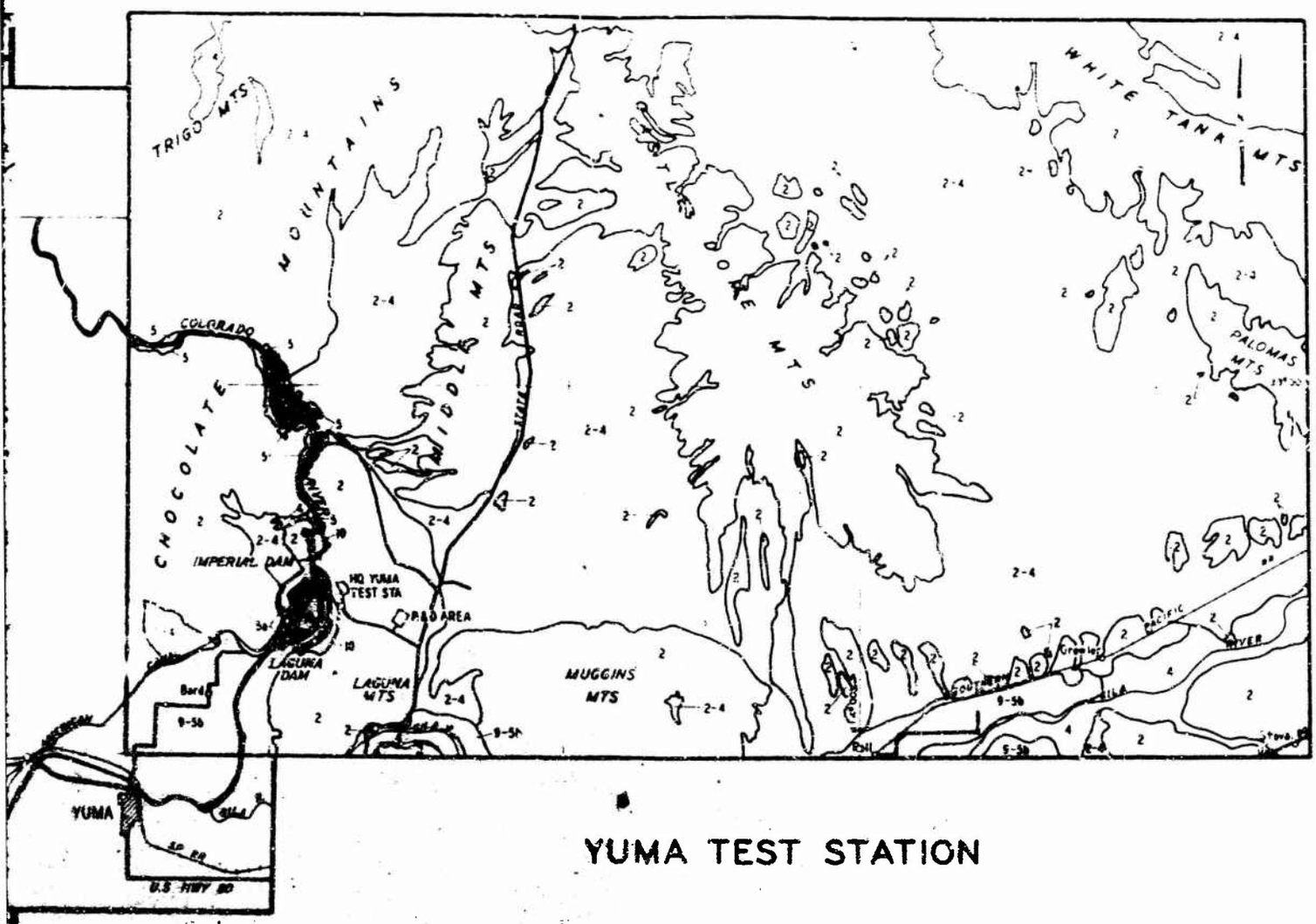
GROUND ANALOGS

PLATE II


CALIFORNIA
ARIZ
32°
30°
28°
26°
114°
112°
San Quintin
Gulf of California


108°
108°
108°
O N A
N E W M E X I
EL PASO
Santa Catalina


SCALE
YUMA SAND HILLS
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
Tarzan



YUMA TEST STATION

VEGETATION ANALOGS

LEGEND

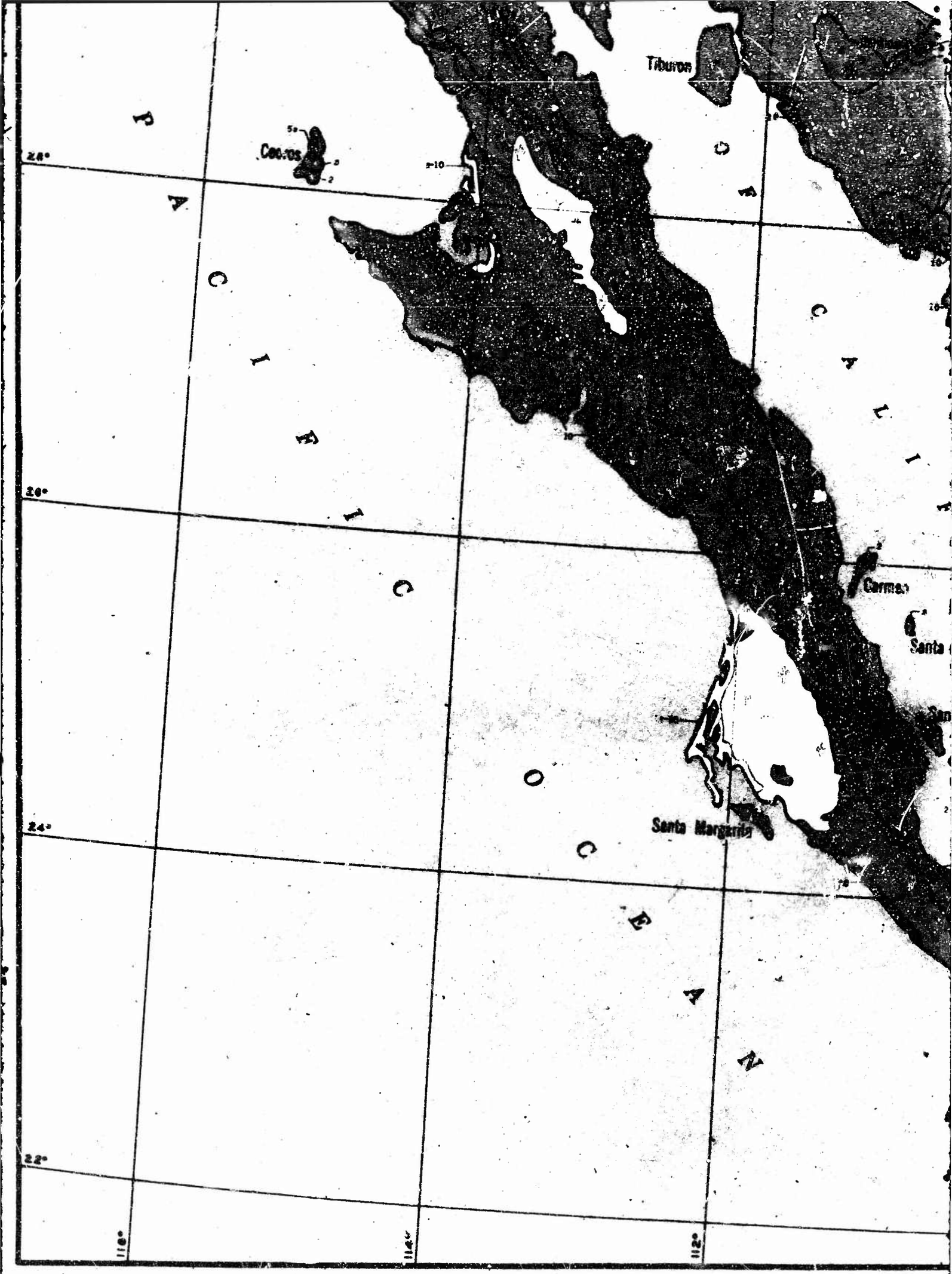
6 Number designates Vegetation mapping unit.

2 Lightface numbers indicate that the unit is found at Yuma.
2 Boldface numbers indicate that the unit is not found at Yuma.

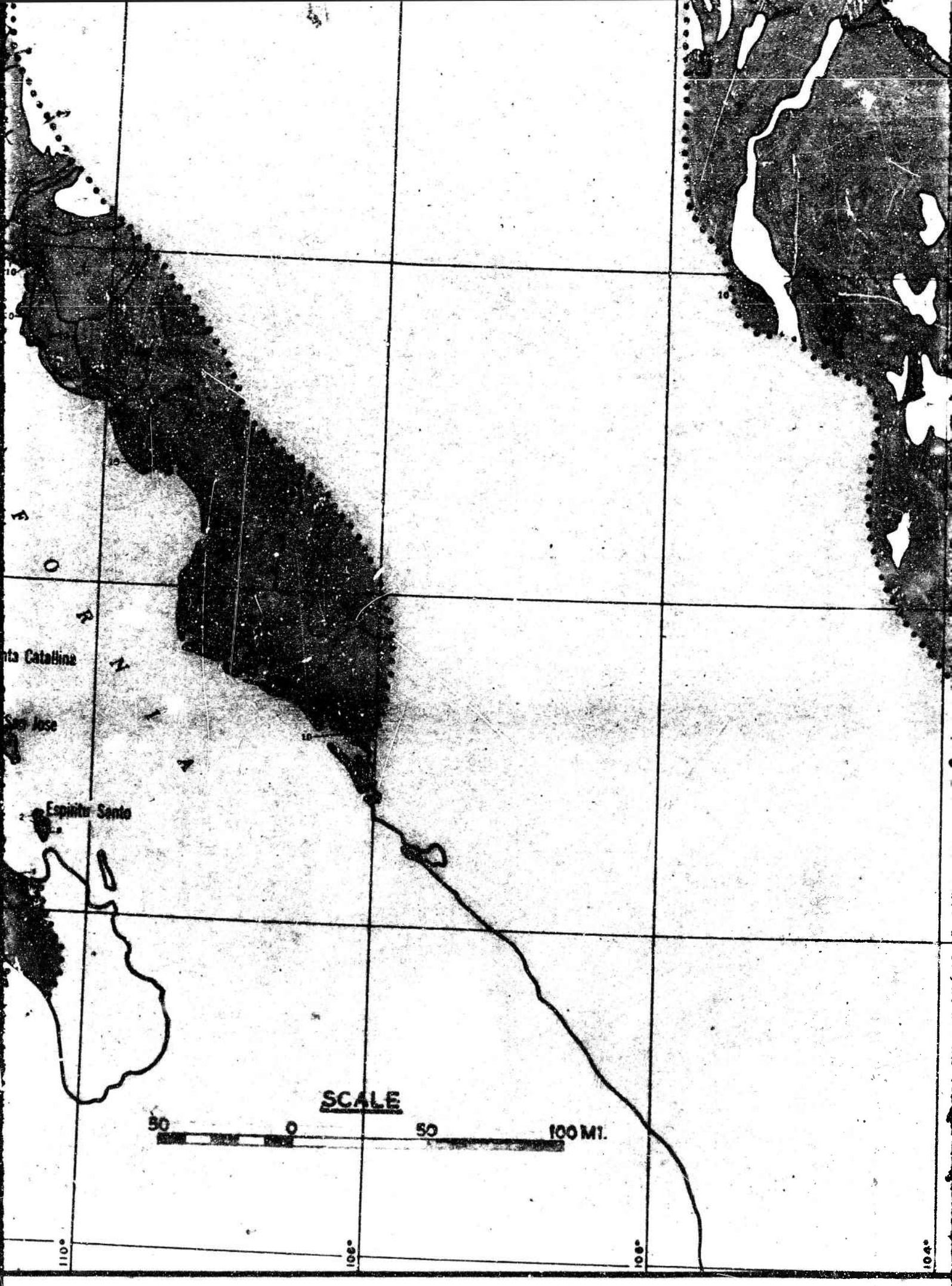
Indicates area of vegetation complex. Two definite vegetational types are present but the scale of mapping precludes delineation.

1-6	Highly Analogous	Unit found at Yuma. In areas of complexes, both units are found at Yuma.
6,5	Partially Analogous	In areas of complexes, one of the two units is found at Yuma.
6	Not Analogous	None of the units are found at Yuma. In areas of complexes, most of the units are found at Yuma.

Yuma assigned components in compiling the Composite Analog Map.


Tiburon
Cedros
Carmen
Santa
Santa Margarita
28°
26°
24°
22°
118°
114°
110°

5


Santa Catalina
San Jose
Espiritu Santo
SCALE
50 0 50 100 MI.
110°
108°
106°
104°

Torreon
San Luis Potosi
102°
100
24°

VEGETATION ANALOGS

LEGEND

8 : Number designates Vegetation mapping unit.

2 Lightface numbers indicate that the unit is found at Yuma.
8 Boldface numbers in Green that the unit is not found at Yuma.

2-8 Indicates area of Vegetation complex. Two distinct vegetation types are present but the scale of mapping precludes orientation.

1	Highly Analogous	Unit found at Yuma. In areas of complexes, both units are found at Yuma.
2.5	Partially Analogous	In areas of complexes, one of the two units is found at Yuma.
8	Not Analogous	None of the units are found at Yuma. In areas of complexes, none of the units are found at Yuma.

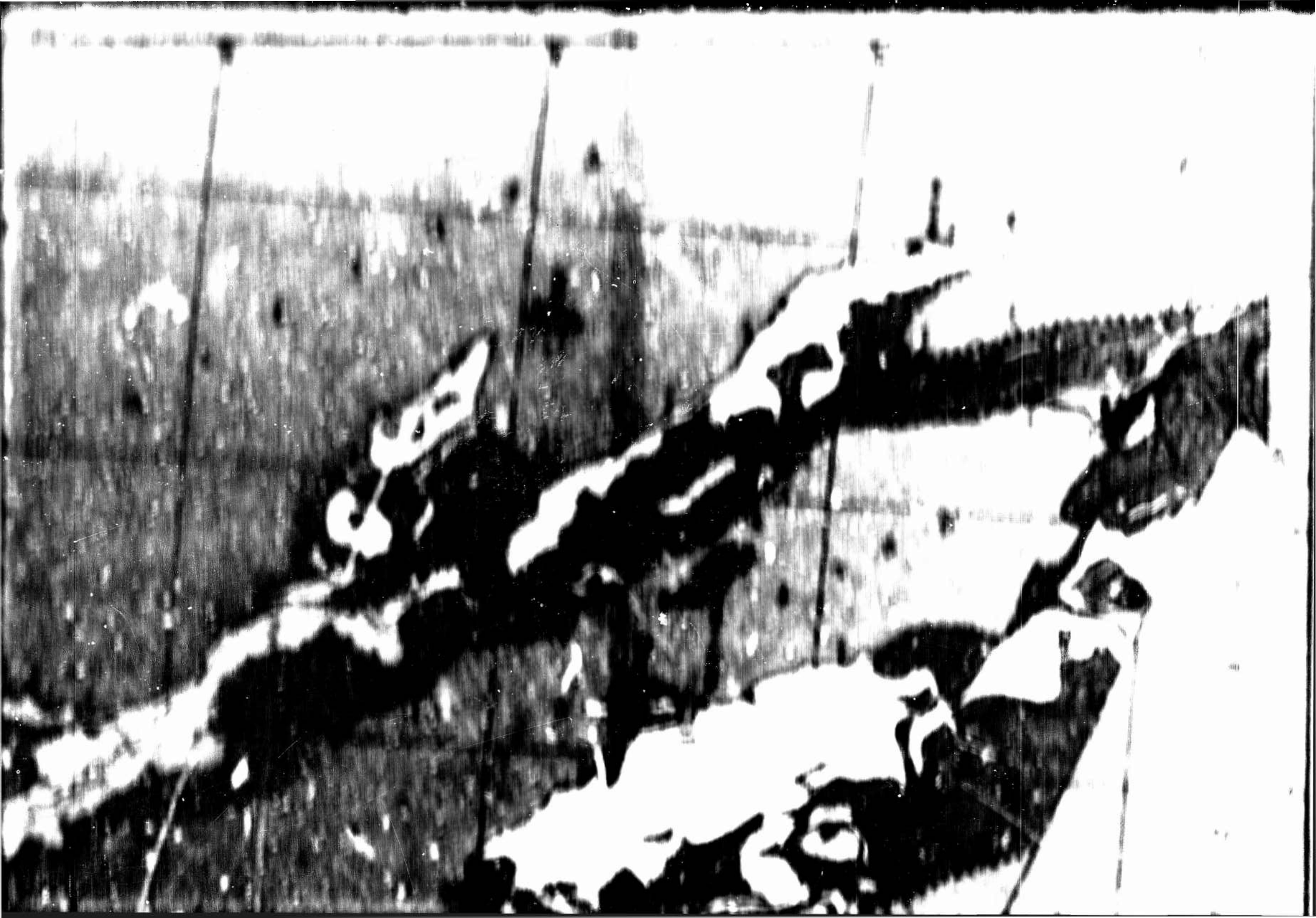
Values assigned components in compiling the Composite Analog Map.

ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

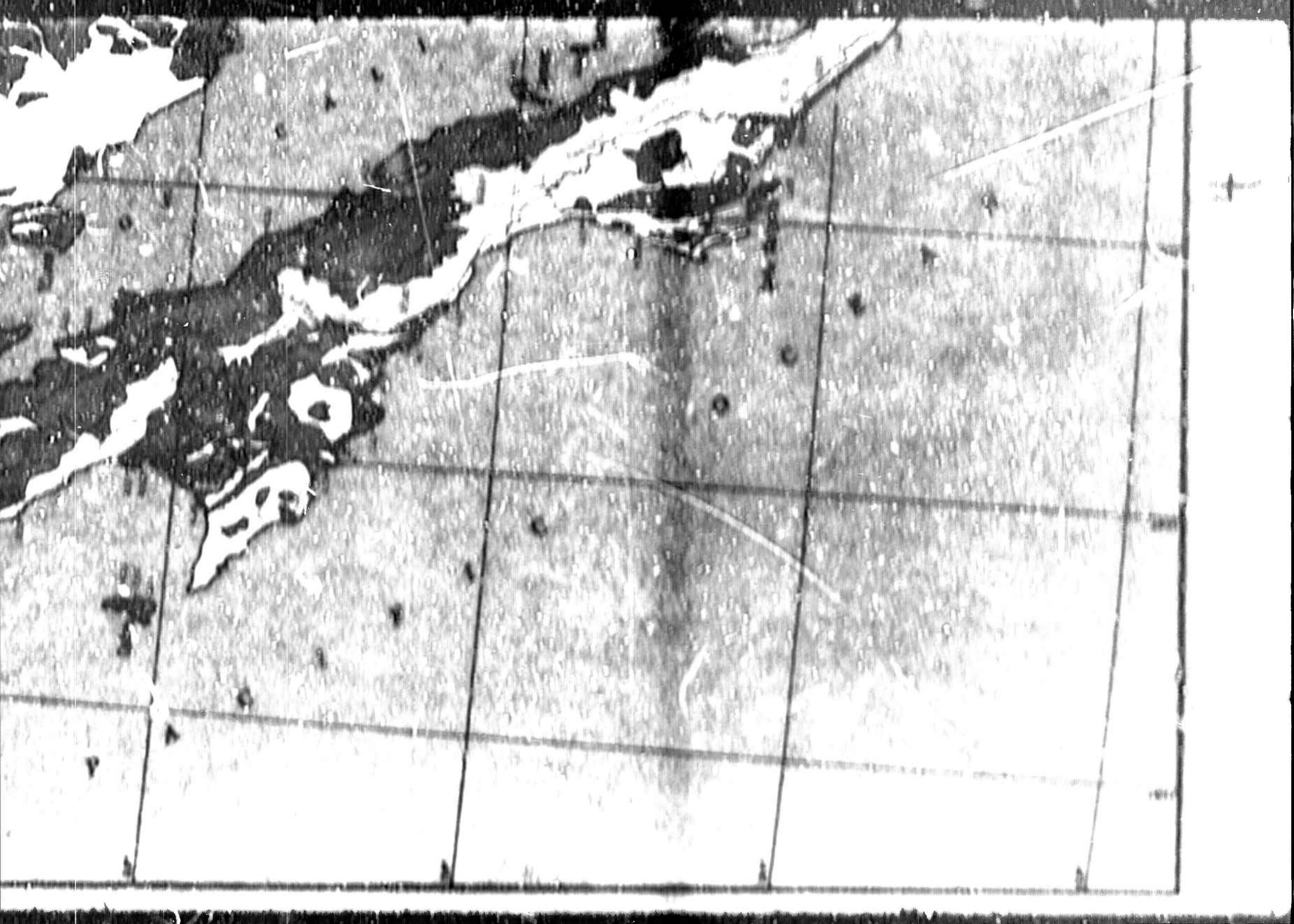
8

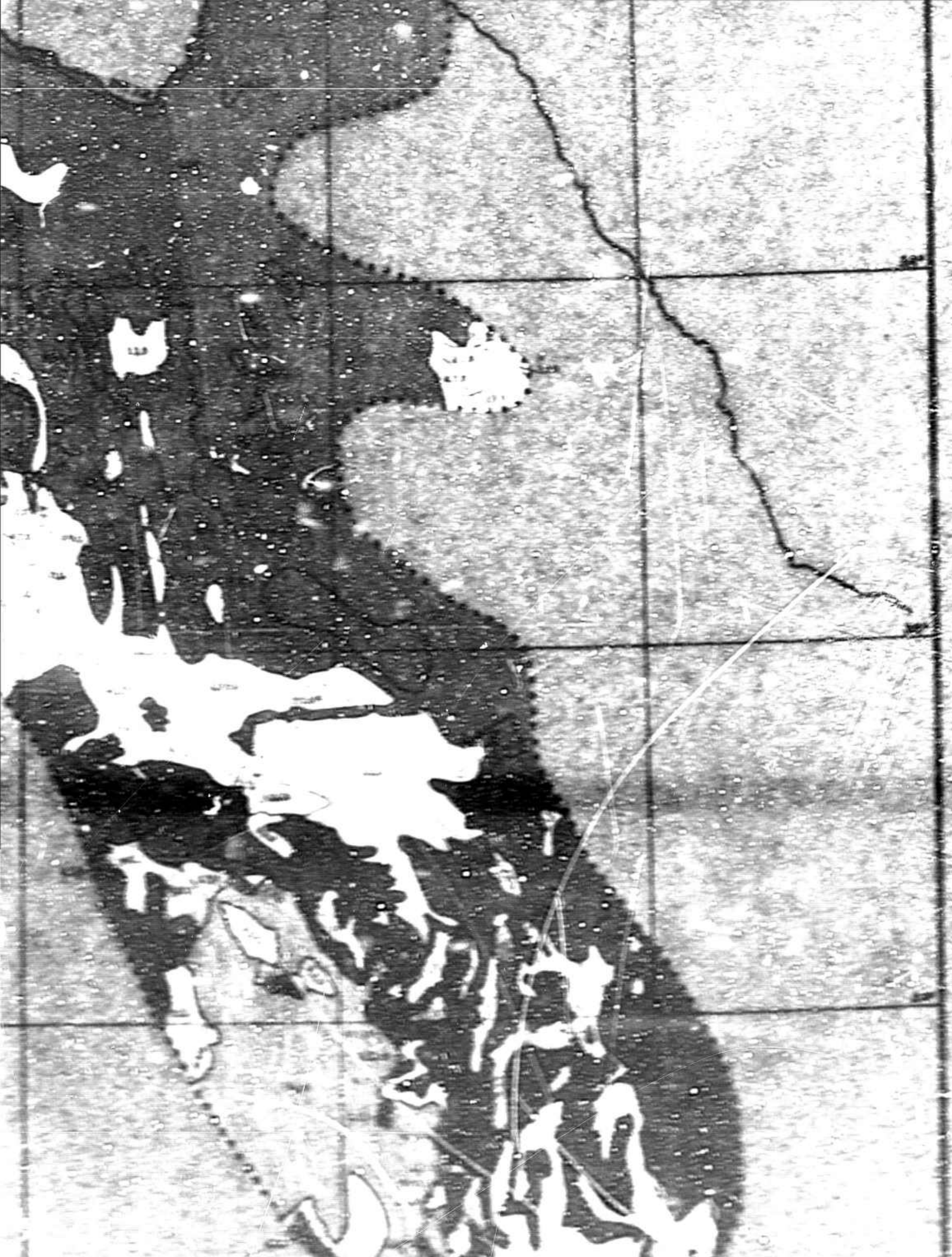
VEGETATION ANALOGS

PLATE 12



T E A S



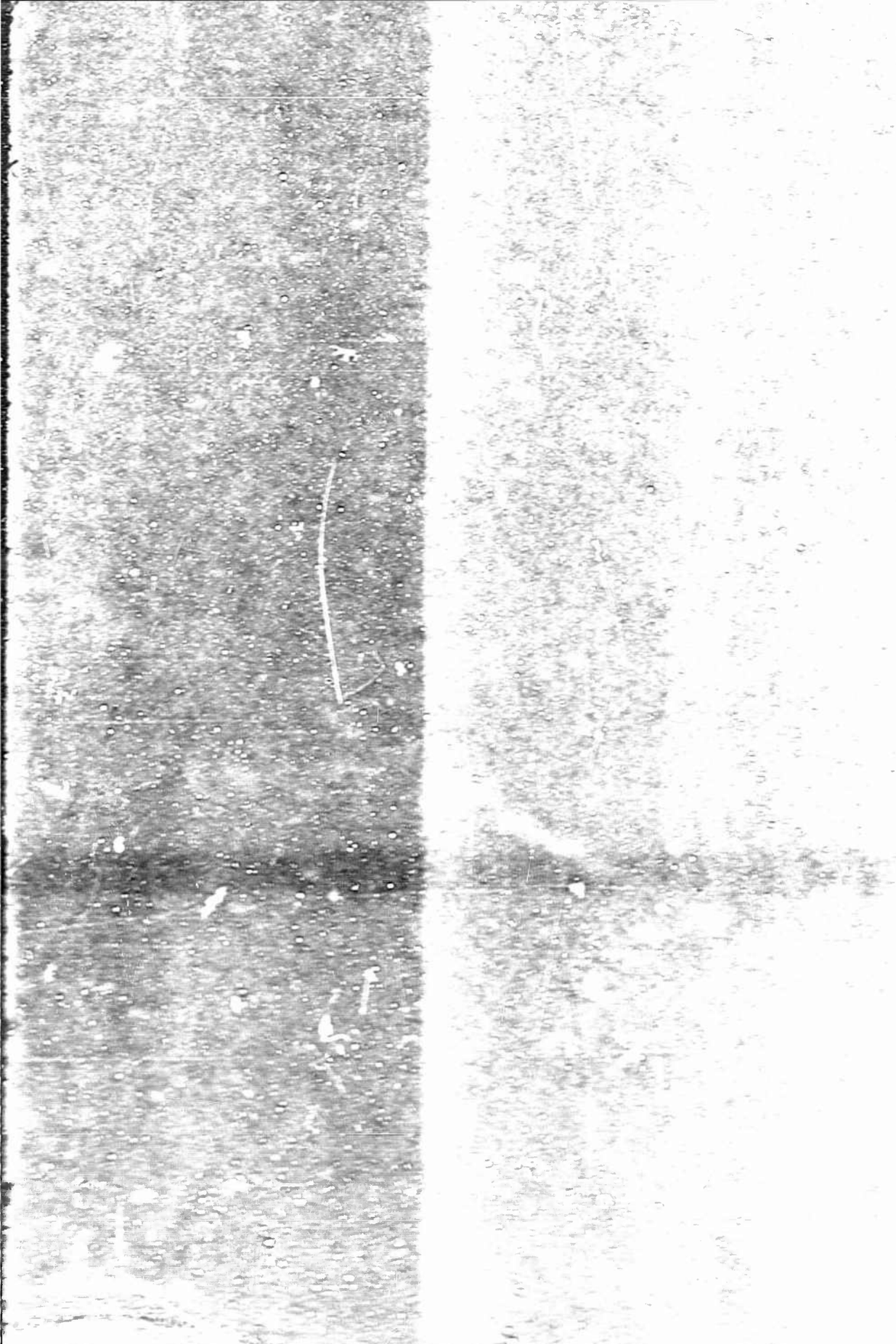


ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

COMPOSITE ANALOGS

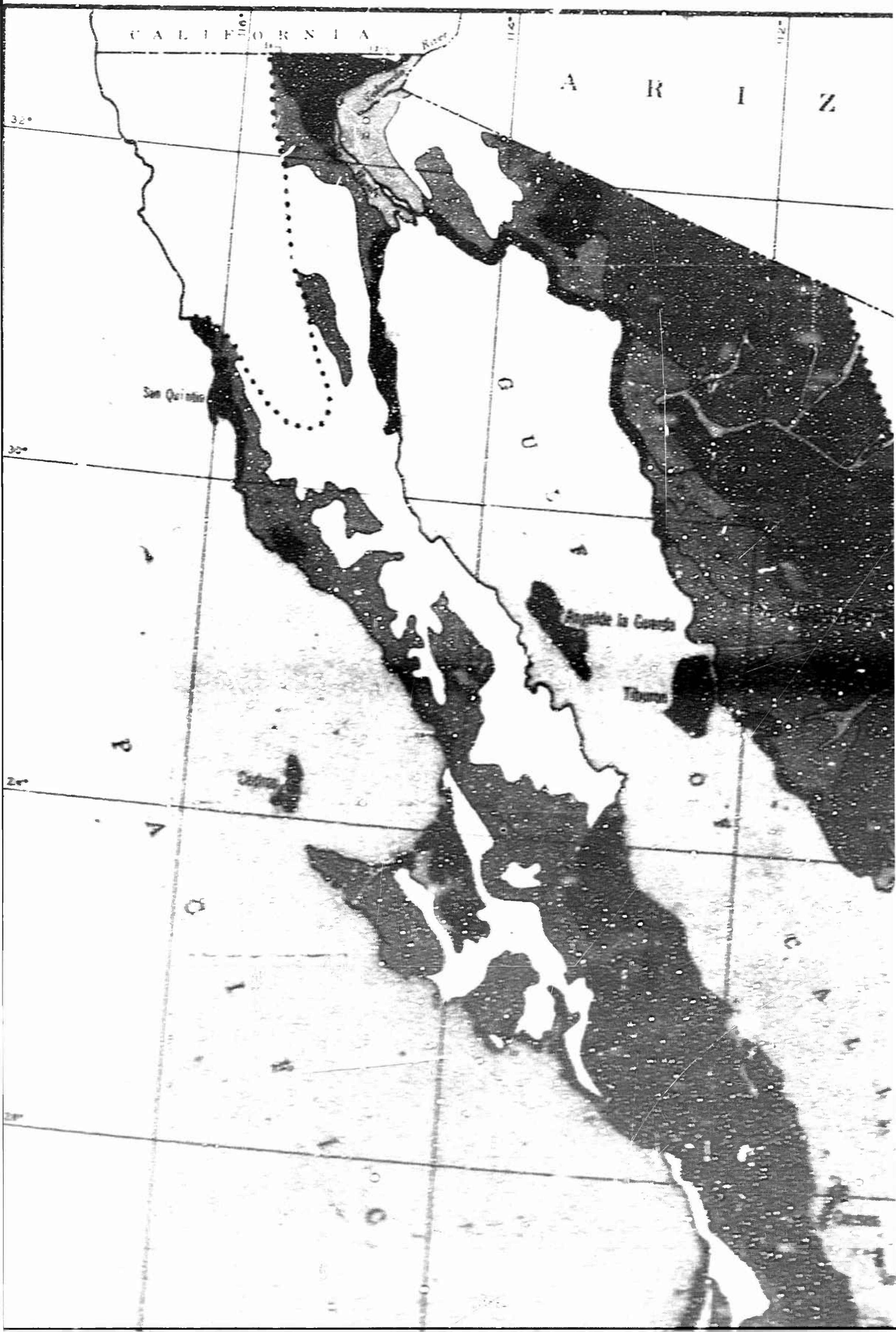
7

PLATE 13



ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

SECTION II: SUPPLEMENTAL MAPS AND TABULATIONS


C A L I F O R N I A
A R I Z
San Quintin
Angel de la Guarda
Tiburon
Cedros
G U L F
P A C I F I C
32°
30°
28°


O N A
N E W M E X I
EL PASO
RIO GRANDE

104°

102°

100°

C O

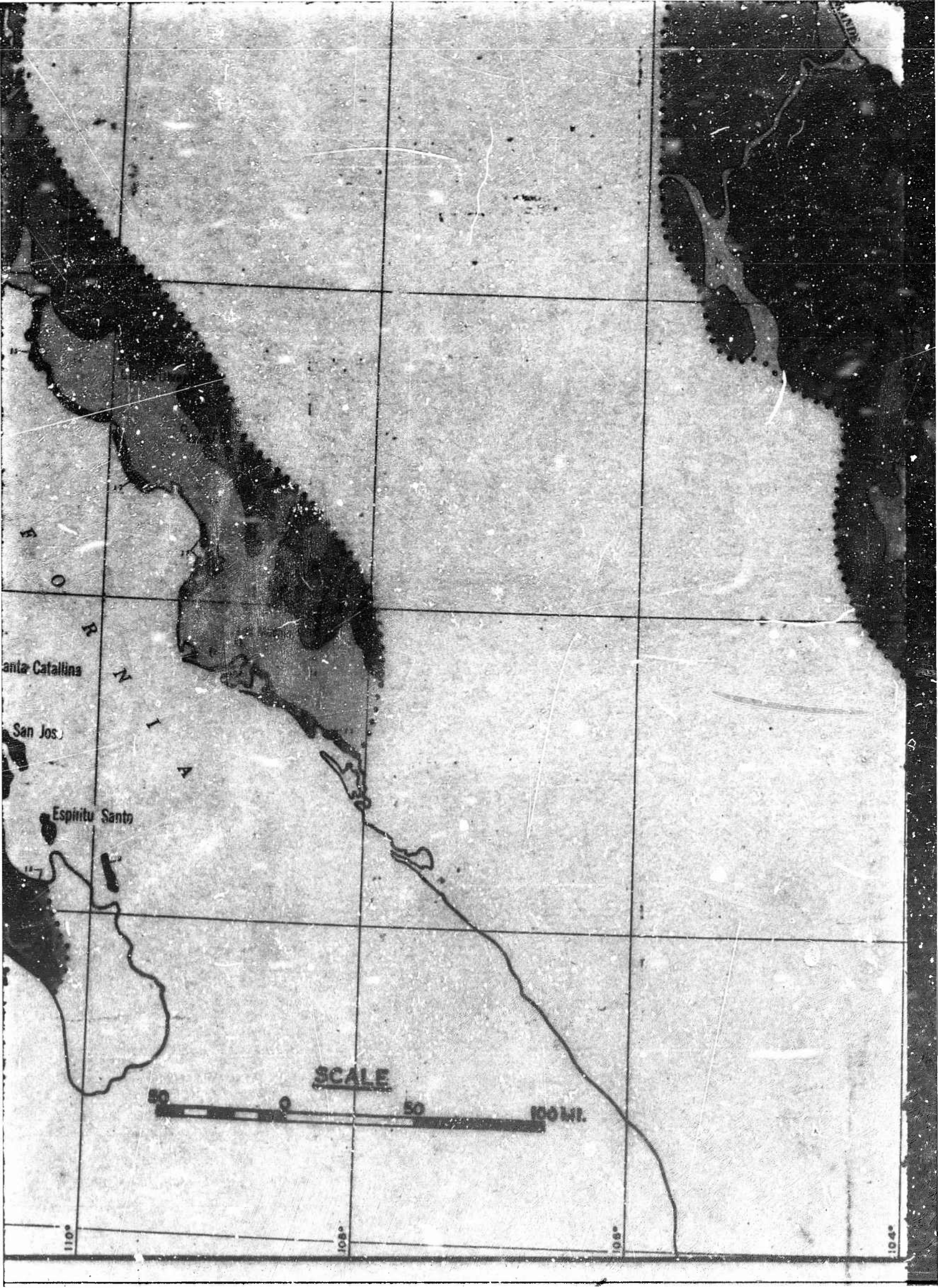
32°

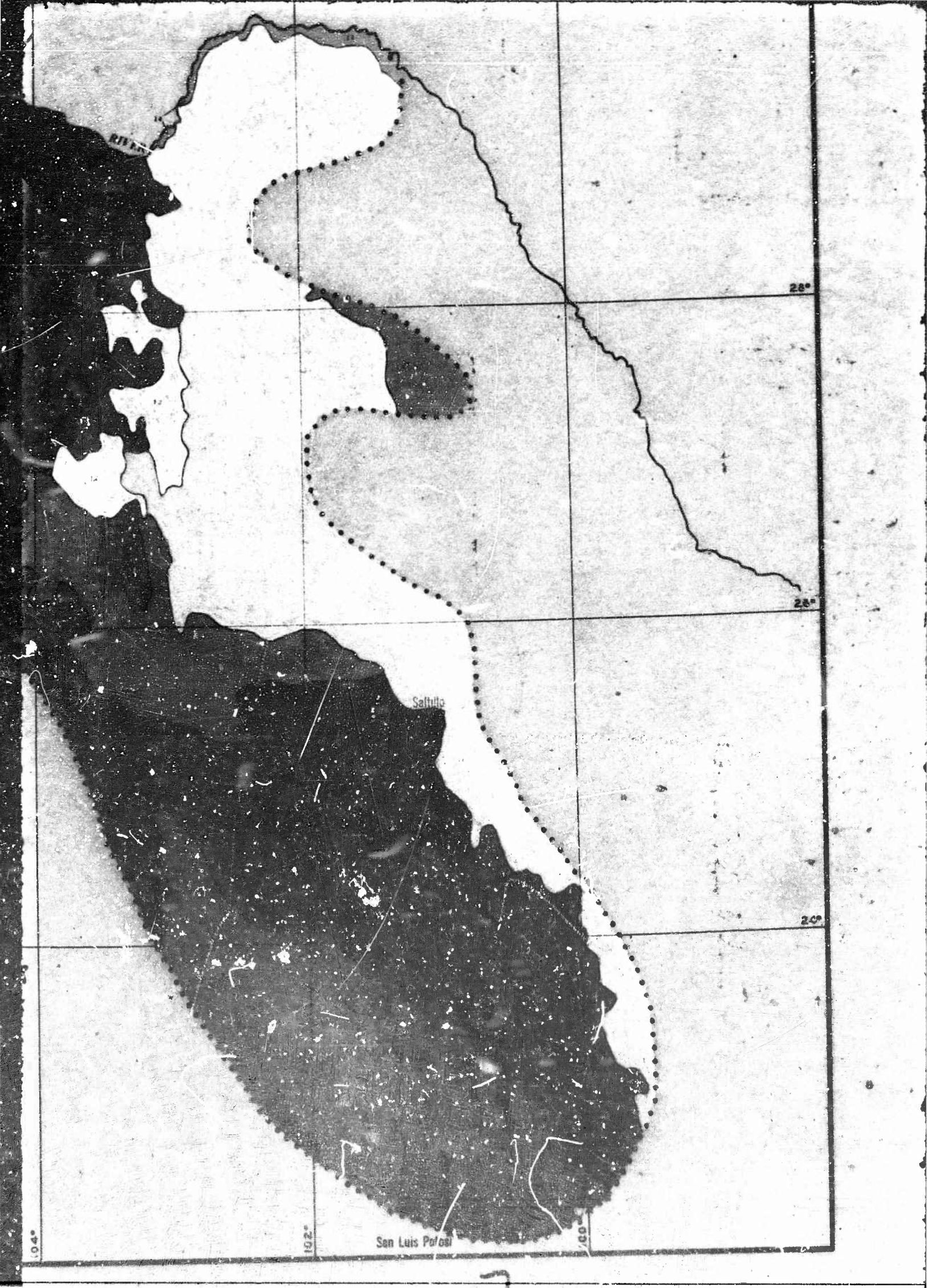
T E X A S

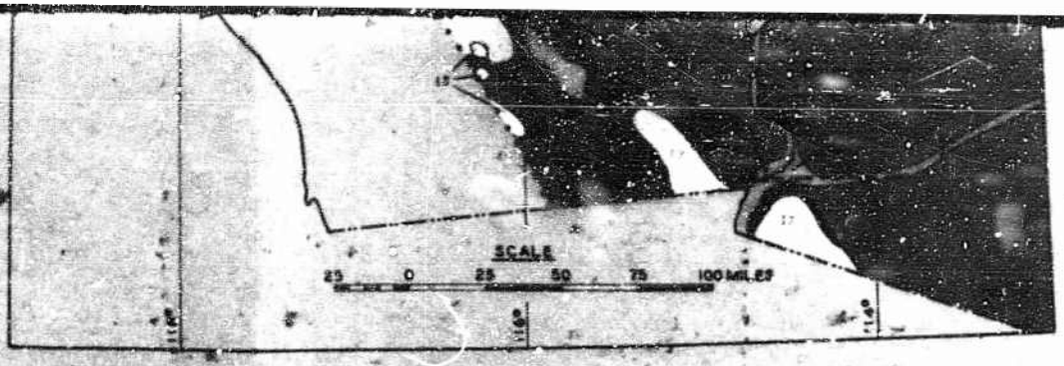
30°

SOUTHWESTERN UNITED STATES

Angeles la Guarda
Tiburon
Cedros
P A C I F I C O C E A N
C A L I F
Carmen
San
Santa Margarita
118°
114°
112°


F O R N I A
anta Catalina
San Jos
Espiritu Santo
SCALE
50 0 50 100 Mi.
110°
108°
106°
104°


28°
28°
Saltillo
24°
San Luis Potosí
104°
102°
100°



SOUTHWESTERN UNITED STATES

PHYSIOGRAPHY

MOUNTAINS: Masses of land, in which summit areas are small in proportion to base dimensions, rising more than 1000 feet above the surrounding terrain. The characteristic slope is declivitous or steep.*

Massive Mountains: Extensive multiple-peaked mountain masses characterized by either a high centrally located core or an elongate crest which rises more than 5000 feet above the surrounding terrain.

1 **Ranges:** Elongate belts of massive mountains.

2 **Massifs:** Roughly circular aggregation of massive mountains.

Ridge Mountains: Continuous ridges of aligned crestal peaks typically rising less than 5000 feet above the surrounding terrain.

3 **Single Ridge:** Single, isolated mountain ridge.

4 **Parallel Ridges:** A series of roughly parallel ridges; some peaks may rise more than 5000 feet above narrow, intervening valleys.

Heterogeneous Mountains: Mountain masses, commonly separated by regions of other terrain types, cover substantially more than 50 per cent of the total area. Any area so mapped is not characterized by either a high centrally located core or an elongate crest.

5 **Peaks and Groups of Peaks:** The mountain masses consist predominantly of peaks and groups of peaks.

6 **Random Ridges:** The mountain masses consist predominantly of discontinuous, randomly oriented ridges.

PLAIN AND MOUNTAIN COMPLEX: Mountains, separated by plains with occasional hills, cover less than 50 per cent of the total area.

7 **Isolated Peaks and Ridges:** The mountain masses consist predominantly of peaks and randomly oriented discontinuous ridges.

8 **Basin and Range:** The mountain masses consist predominantly of roughly parallel ridges.

HILL LANDS: Areas characterized by prominences of small summit area, with characteristic slopes gentle to steep, rising less than 1000 feet above the surrounding terrain. Plains regions between hills may range as high as 75 per cent of the total area.

9 **Parallel Hills:** Prominences consist predominantly of parallel elongate hills with characteristic slopes moderate to steep.

10 **Random Hills:** Prominences consist predominantly of randomly distributed hills with characteristic slopes moderate to steep.

11 **Volcanics:** Prominences consist predominantly of randomly distributed conical and irregularly shaped hill forms. Relief-hill areas characterized by rough surface of angular to jagged cobbles and blocks. Slopes may range from gentle to precipitous. In rare instances, conical hills may be absent.

12 **Sand Dunes:** Prominences, consisting chiefly of eolian sand, commonly (but not invariably) change shape and position rapidly. Areas characterized by a total lack of organized drainage lines and moderate to steep slopes.

13 **PLATEAUS:** Elevated masses of land characterized by extensive, more or less flat-lying summit areas bounded on one or more sides by scarps† (if at all are indicated on maps by a hachured line; all other boundaries are more or less gradational.) Dissected plateaus are indicated by a lined overprint) where less than 85 per cent of the original surface remains.

PLAINS: Extensive tracts of land with characteristic slopes flat to gentle. Less than 25 per cent of the surface is occupied by hills, and local relief within the plains seldom exceeds 50 feet. (Because of the transitional nature of most plains types, boundary lines are often difficult to establish and in many cases are quite arbitrary.)

14 **Alluvial Plains:** Floodplains, terraces and subaerial deltas of major streams.

15 **Coastal Plains:** Plains bordering the sea and extending inland to the nearest elevated land, or to a gradational boundary with another plains type.

16 **Depression Plains:** Low-lying plains of interior drainage bounded on two or more sides by scarps or steep mountain fronts, and commonly characterized by a centrally located brackish or saline lake, generally but not invariably ephemeral.

17 **Desert Plains:** Interior plains not readily classifiable as alluvial or depression plains. These plains are often formed or significantly modified by eolian deposition or erosion.

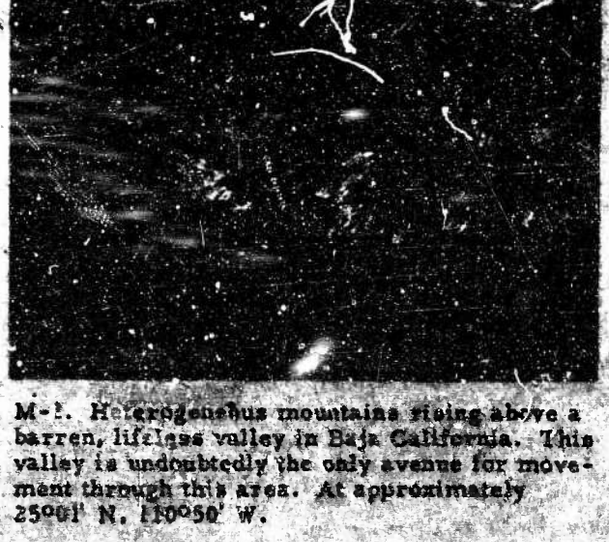
* Slope classification: flat = 0 to 2 degrees, gentle = 2 to 6 degrees, moderate = 6 to 14 degrees, declivitous = 14 to 26.9 degrees, steep = 26.9 to 45 degrees, precipitous = greater than 45 degrees.

† A scarp is defined as a more or less continuous precipitous slope exhibiting more than 100 feet of relief. Scarp height is indicated where known.

ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT
PHYSIOGRAPHY

I. MOUNTAIN

Mountains are masses of land which exhibit summit areas that are small in proportion to basal dimensions, and which rise more than 1,000 ft above the surrounding terrain. Massive, heterogeneous, and parallel-ridge mountains along with basin-and-range regions (plain and mountain complexes) occupy approximately 70 per cent of the Mexican Desert. The mountains of Baja California occur as tilted fault blocks along the eastern side of the peninsula. These mountains are primarily massive intrusions in the northern half of the peninsula, whereas the southern half consists of complex extrusives—in some areas intricately dissected into peaks and groups of peaks. A small part of the Sierra Madre Occidental forms an imposing range of mountains in the southern part of Sonora. These mountains are a succession of relatively narrow, continuous, northwest-southeast belts of rugged peaks and groups of peaks separated by longitudinal valleys, which form transverse canyons trending westward to the coast. The Sierra Madre Oriental of the Chihuahuan Desert begins with a series of inconspicuous ranges of 5,000-ft elevation just south of the Rio Grande, and rises gradually southward until it attains magnificent proportions with peaks



M-1. Heterogeneous mountains rising above a barren, lifeless valley in Baja California. This valley is undoubtedly the only avenue for movement through this area. At approximately 25°01' N, 110°50' W.

M-2. From the air, Mulege Val green finger la[illegible] on the brown l barren mountain lies a portion California and the entrance to th Conception. At 26° 54' N, 111°5

M-4. Mountain range of Baja California terminating in wave-cut cliffs along the Gulf of

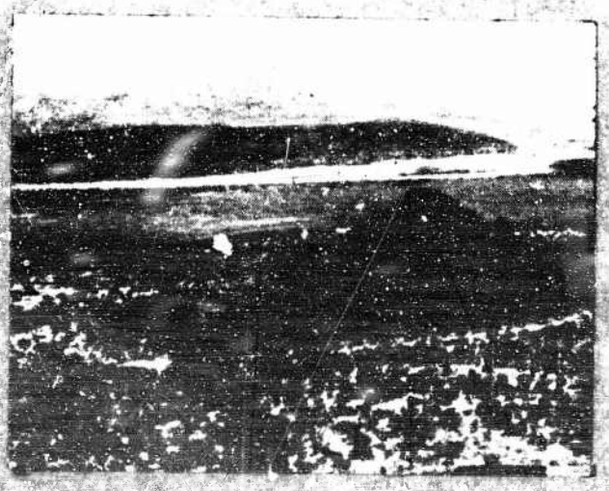
M-5. Desert erosion—dee cut by surface water in the

PHYSIOGRAPHY: DESCRIPTION

AINS

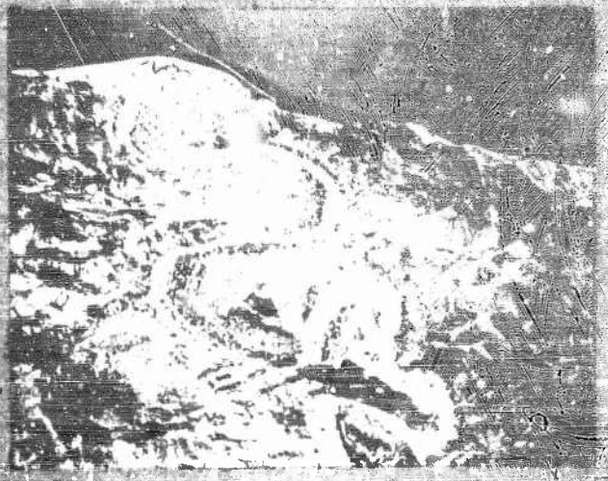
reaching 13,000 ft along the southeastern limit of the desert area. These mountains do not act as a continuous barrier, because the ramifications of the desert basins lying to the west extend eastward through the passes of the several ranges and in many places establish easy communication with the coastal lowlands. The northern parts of the Sonoran and Chihuahuan Deserts are a continuation of the basin-and-range country of the United States. Generally speaking, these basin-and-range areas consist of isolated mountain blocks rising above a vast intervening sea of basins or plains traversed by intermittent streams. Lagunas or shallow ephemeral playa lakes, fed by intermittent streams which head in the nearby mountains, occur in the lowest parts of the basins. Another basin-and-range region similar to those described above is located in the southern part of the Chihuahuan Desert. The mountains are characterized by steep, rocky, and sparsely vegetated slopes. They are composed chiefly of igneous and sedimentary rocks, but locally consist of metamorphic rocks. The relief within the mountains ranges from fifty to a few thousand feet.

e Valley resembles a own land. Beyond the rtion of the Gulf of to the Bahia de la 111°59' W.



M-3. Cerrito de la Trinchera, a residual hill rising above the plain or basin within the basin-and-range region of Sonora. The Magdalena River and basin ranges are in the background. At 30°23' N, 111°32' W.

-deep canyons n the sedimen- ntains of Baja



M-4. Incised meanders several hundred feet deep cut by the river along its eastward course through the mountains of

NS AND PHOTOGRAPHS

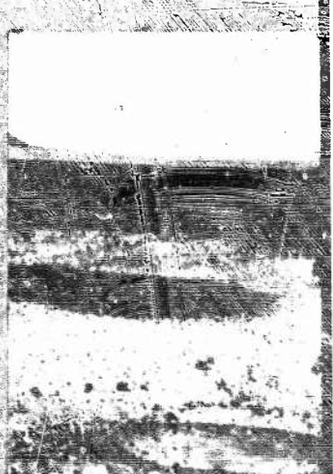
II. HILL LANDS

Hill lands are areas characterized by prominences having small summit areas and gentle to steep slopes that rise less than 1,000 ft above the surrounding terrain. Areas mapped as hill lands may be individual hill masses or may include hills separated by plains that occupy as much as 75 per cent of the area. Random hills, sand dunes, and volcanics occupy approximately 6 per cent of the Mexican Desert. Random hills in northern Baja California lie at lower elevations than, and to the west of the main mountain range. In the central part of Baja California, hills cover two sizeable areas within the Desierto de Vizcaino. Hill lands in northern Sonora, which include extensive plains, occur along the coast and extend inland to the basin-and-range region. In northern Chihuahua, random hills lie discontinuously along the western side of the Rio Grande and north of
are the T
and the
flows, vol
the Desie
Sonora a
Sand dune
central p
compositi
to consoli
400 ft. T

H-1. Saw-toothed hills rising above a sandy plain in northern Sonora. Note the wind-blown sand accumulations along the base of the hills. At 31°51' N, 113°42' W.

H-2. Las Tres Virgenes (The three volcanic peaks near the Baja California. At 27°28' N.

H-4. Marine terraces forming a bench along the base of a group of hills in Baja California. At [illegible] 114°09' W.



H-5. MacDougal crater
cal. volcanic region of n
Sonora. At 113°36' W.

NDS

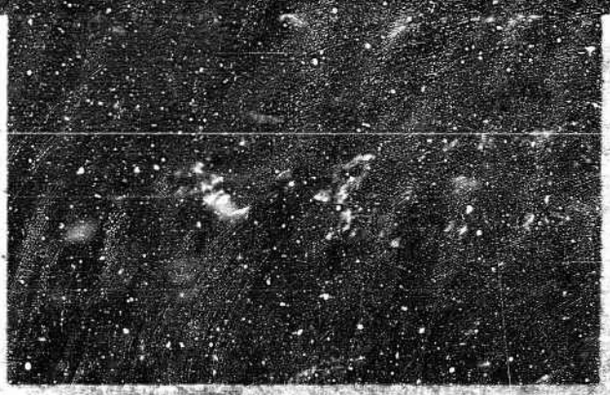
th of its junction with the Rio Conchos. The volcanics within the study area the Three Virgins—three volcanic peaks located in central Baja California— the Pinacate region of northwestern Sonora, which is characterized by lava ws, volcanic cones, and craters. Sand dunes are concentrated in portions of Desierto de Vizcaino and the Magdalena Plain of Baja California. In northern ora a relatively large area of dunes is referred to as the Gran Desierto. d dunes also occur in the northern part of the Chihuahuan Desert and in its tral portion along the western margin of the Sierra Madre Oriental. The nposition of the hill lands in the Mexican Desert varies from unconsolidated consolidated material, and the relief within these areas varies from 50 to ft. The vegetation provides barren to sparse coverage.

s (The Three Virgins), ar the east coast of 28' N, 112° 7' W.

H-1. A field of barchan dunes along the coast of Baja California north of Magdalena Bay. At 24°55' N, 112°17' W.

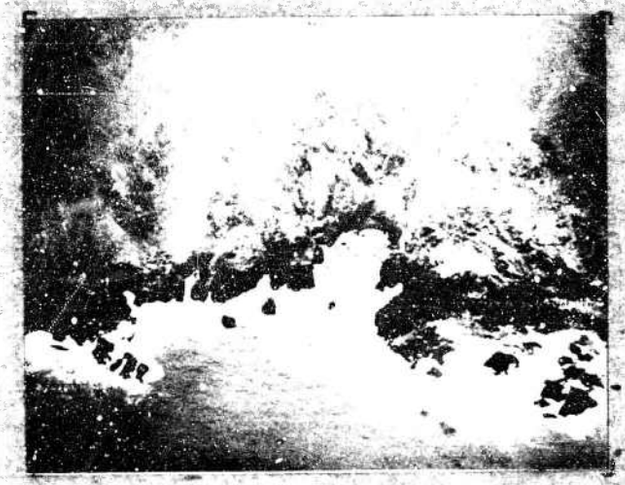
crater in the Pinacate on of northern 6' W, 31°56' N.

H-6. A highly dissected band of foothills along a mountain front in Baja California. At approximately 32°28' N, 115°45' W.



M-1. Heterogeneous mountains rising above a barren, lifeless valley in Baja California. This valley is undoubtedly the only avenue for movement through this area. At approximately 25°01' N, 110°50' W.

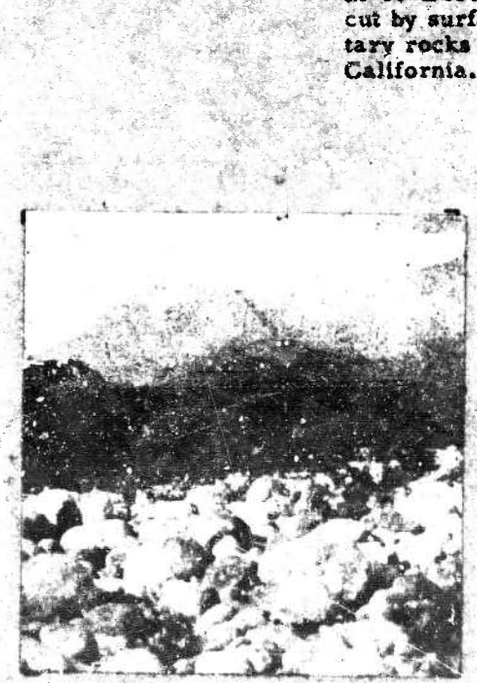
M-2. From the air, Mulege Valley green finger laid on the brown land barren mountains lies a portion of California and the entrance to the Conception. At 26°54' N, 111°59'



M-4. Mountain range of Baja California terminating in wave-cut cliffs along the Gulf of California. At approximately 29°30' N, 114°00' W.

M-5. Desert erosion—deep c cut by surface water in the se tary rocks of the mountains o California. Location unknow

M-7. Granite outcrops within the Sierra de San Pedro Martir. This type of terrain forms a barrier to cross-country movement. At 30°45' N, 115°18' W.



M-8. Accumulation of boulders in a stream bed within the mountains of Baja California. At 25°40' N, 111°38' W.

M-
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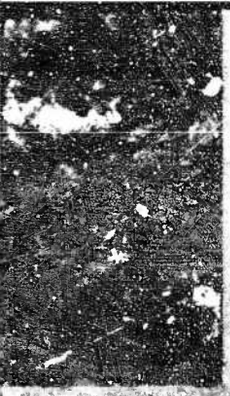
fla
32°



alley resembles a
land. Beyond the
n of the Gulf of
tha Bahia de la
59' W.

M-3. Cerrito de la Trincheara, a residual hill rising above the plain or basin within the basin-and-range region of Sonora. The Magdalena River and basin ranges are in the background. At 30°23' N, 111°32' W.

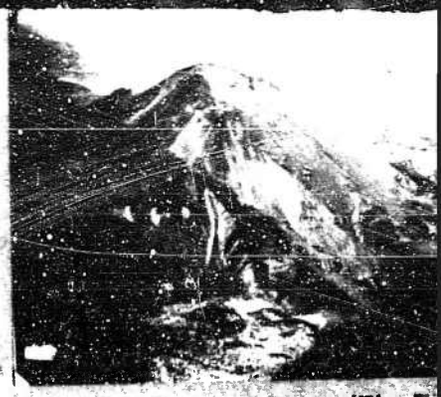
eep canyons
he sedimen-
ins of Baja
known.

M-6. Incised meanders several hundred feet deep cut by the river along its eastward course through the mountains of Baja California to the Gulf of California. At 24°30' N, 110°42' W.

M-9. An alluvial fan formed at the base of low mountains in Baja California where the stream enters the flat plain in the foreground. At 32°15' N, 115°25' W.

M-10. A dike in cross section within the mountains of Sonora. Location unknown.

H-1. Saw-toothed hills rising above a sandy plain in northern Sonora. Note the wind-blown sand accumulations along the base of the hills. At 31°33' N, 113°35' W.



H-2. Las Tres Virgenes (The T
three volcanic peaks near the ea
Baja California. At 27°28' N, 11

H-4. Marine terraces forming a bench along the base of a group of hills in Baja California. At 28°39' N, 114°05' W.

H-5. MacDougal crater i
cate volcanic region of no
Sonora. At 113°36' W, 31

H-7. The flat, dusty surface of a dry playa within the hill land region of Baja California. At 29°43' N, 114°42' W.

H-8. View across the
the Pinacate region wit
canic peaks in the back
31°39' N, 113°35' W.

hree Virgins),
st coast of
12°37' W.

H-3. A field of barchan dunes along the coast of Baja California north of Magdalena Bay. At 24°55' N, 112°17' W.

n the Pina-
rthern
°56' N.

H-6. A highly dissected band of foothills along a mountain front in Baja California. At approximately 32°28' N, 1'5045' W.

va field in
the vol-
round. At

ANALOGS OF YUMA TERRAIN

IN THE

MEXICAN DESERT

PHYSIOGRAPHY

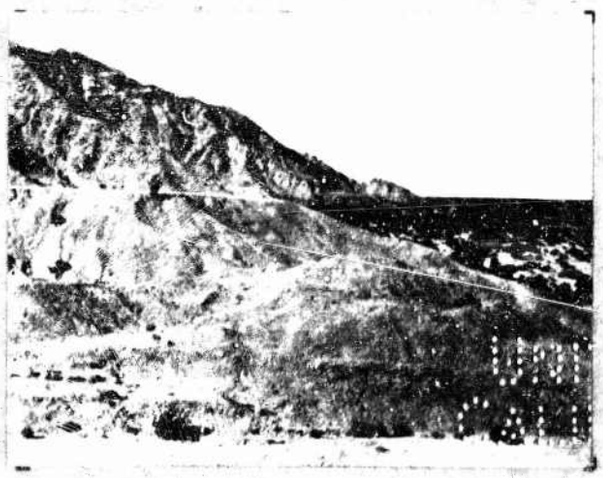
DESCRIPTIONS AND PHOTOGRAPHS

III. PLAIN

Plains are extensive tracts of flat to gently sloping land with hills occupying less than 25 per cent of the surface. All major physiographic types of plains occur within the Mexican Desert. These plains vary in size, origin, and composition, and occupy approximately 20 per cent of the study area. Along the western margin of Baja California are two relatively undissected wind-swept desert plains, the Magdalena Plain and the eastern part of the Desierto de Vizcaino. In northern Baja California, moderately dissected plains occur within the mountains. The depression plain along the international boundary is a continuation of the Salton Trough of California. This trough was once continuous to the Gulf of California, but alluvium from the Colorado River has filled the lower portion—forming the Colorado alluvial plain and delta. The alluvial plains of Sonora occur as narrow branching strips within the basin-and-range region, and

P-1. The monotony of an extensive desert plain in Baja California is broken by the River Canalla. At 25°31' N, 111°53' W.

P-2. View across Sonoyta Oa Sonora. Basin ranges form a crest line in the background. 112°55' W



P-4. A terrace level rising above the alluvial plain eastward from Sierra Major in Baja California. At 32°10' N, 115°15' W.

P-5. Desert pavement of closely packed rock f coated with magnesium oxide—nea- Sierra Las Exact loc on unknown.

PHYSIOGRAPHY: DESCRIPTIO

as a relatively wide area lying between the mountains and the coast in the southern part. In Sonora a narrow coastal plain extends discontinuously along the area. Immediately landward of the coastal plain in northern Sonora are irregularly shaped desert plains, generally bordered on the north and south by hill lands and on the east by the basin-and-range region. Alluvial plains in northern Chihuahua occur as relatively narrow bands along the Rio Conchos and as discontinuous bands along the Rio Grande, the latter river forming the northern limit of the Mexican Desert. The largest desert plains in the Mexican Desert occur in the central and southwestern portion of the Chihuahuan Desert. Other desert plains occupy areas in the northwestern and east central parts. Plains within the study area are composed predominantly of unconsolidated material ranging from clay to sand and gravel. Local relief seldom exceeds 50 f

yta Oasis in northern
orm a continuous
ound. At 31°50' N,

P-3. A relatively narrow coastal plain in Baja California along the Pacific Ocean. A band of sand dunes in the foreground is interrupted by a small river. At 26°15' N, 112°30' W.

ment--a mosaic
rock fragments
sium or iron
Las Pintas.
nown.

P-6. Tidal mud flats appearing as dark-toned areas along the sandy coastal plain in Baja California. At 24°47' N, 112°15' W.

IONS AND PHOTOGRAPHS

IV. PLAT

[illegible] characterized by extensive, more [illegible] sides by scarps. D s- [illegible] the original flat- [illegible] 4 per cent of the [illegible] small, undissected [illegible] characterized by a flat to undu- [illegible] surface, and a large, maturely dissected plateau in the south central part

PL-1. A wide, flat valley bordered by steep scarps in a plateau region in Baja California. Tributaries of the main stream have formed fingerlike projections of the summit area. At 26°45' N, 112°46' W.

PL-2. A maturely dissec California which has resu of scattered buttes and m 112°28' W.

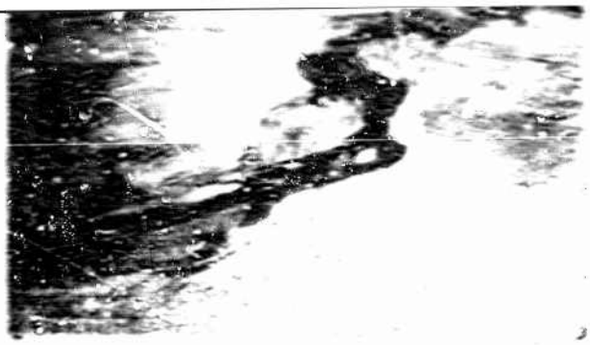
PL-4. The oasis valley of San Jose de Comundu within the plateau region of Baja California. This valley continues westward to the coastal plain. At 26°45' N, 112°09' W.

where less than 40 per cent of the summit area remains. Scattered buttes and mesas also occur within this area. The remaining plateau region within the study area occurs in southeastern Sonora as a dissected portion of the Sierra Madre Occidental. Bare rock and stony soils compose from 20 to 100 per cent of the surface within the plateau regions of the study area. Relief of the summit areas generally ranges from 0 to 30 ft, but the depth of dissection along the major drainageways is usually from 100 to 600 ft.

dissected plateau in Baja
s resulted in a landscape
and mesas. At 26°55' N,

PL-3. Recession along a plateau front which has formed a land of hill lands adjacent to the escarpment. Note the almost constant elevation of the plateau summit area in the background. At 24°31' N, 110°55' W.

PL-5. Talus slopes along a plateau escarpment bordering the lush valley floor of San Isidro in Baja California. Location unknown.



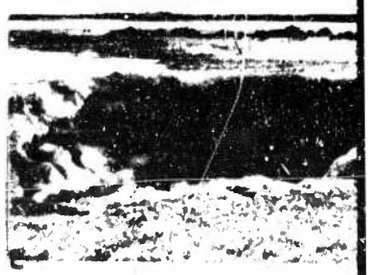
P-1. The monotony of an extensive desert plain in Baja California is broken by the River Canalla. At 29°35' N, 111°53' W.

P-2. View across S[illegible] is Sonora. Basin ranges form a con crest line in the background. At 112°54' W.

P-4. A terrace level rising above the alluvial plain eastward from Sierra Major in Baja California. At 32°10' N, 115°15' W.

P-5. Desert pavement—a [illegible] of closely packed rock frag[illegible] coated with magnesium or i[illegible] oxide—near Sierra Las Pin[illegible] Exact location unknown.

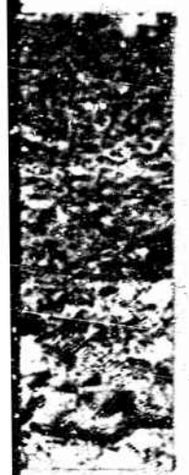
P-7. Two of the group of active mud volcanos in flood plain of Rio Hardy in the vicinity of Cerros Prieto. At approximately 32°20' N, 115°20' W.



P-8. A collapsed mud volca[illegible] caldera in miniature—near [illegible] lake. Location unknown.

asts in northern
a continuous
. At 31° 50' N,

P-5. A relatively narrow coastal plain in Baja California along the Pacific Ocean. A band of sand dunes in the foreground is interrupted by a small river. At 26°15' N, 112°39' W.



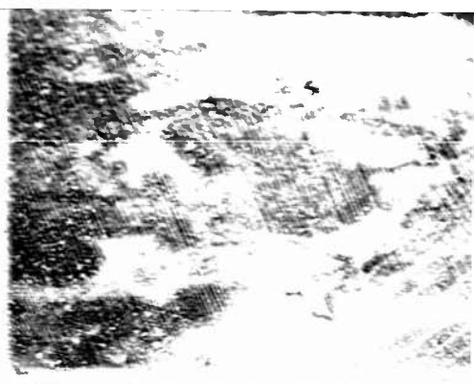
—a mosaic
fragments
or iron
s Pintas.
n.

P-6. Tidal mud flats appearing as dark-toned areas along the sandy coastal plain in Baja California. At 24°47' N, 112°15' W.

volcano—a
ear volcano
n.

P-9. A shell mound along the Gulf of California north of San Felipe. These mounds reach heights of several feet. At 31°05' N, 114°50' W.

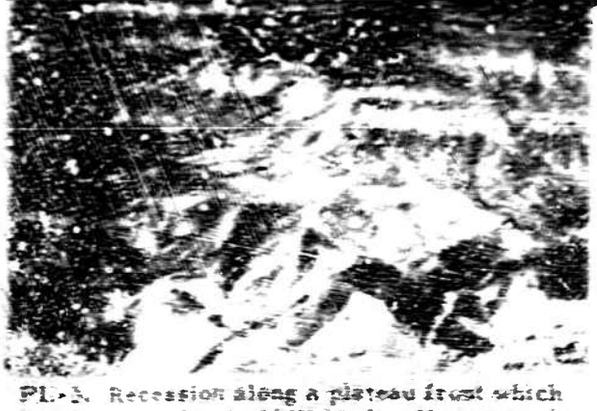
PL-1. A wide, flat valley bordered by steep scarps in a plateau region in Baja California. Tributaries of the main stream have formed fingerlike projections of the summit area. At 26°45' N, 112°46' W.



PL-2. A maturely dissected plateau [illegible] California which has resulted in a la[illegible] of scattered buttes and mesas. At 2[illegible] 112°28' W.

PL-4. The oasis valley of San Jose de Comundu within the plateau region of Baja California. This valley continues westward to the coastal plain. At 26°45' N, 112°09' W.

o plateau in Baja
ed in a landscape
as. At 26° 55' N,



PL-3. Recession along a plateau front which has formed a band of hill lands adjacent to the escarpment. Note the almost constant elevation of the plateau summit area in the background. At 29°21' N, 114°55' W.

PL-5. Talus slopes along a plateau escarpment bordering the lush valley floor of San Isidro in Baja California. Location unknown.

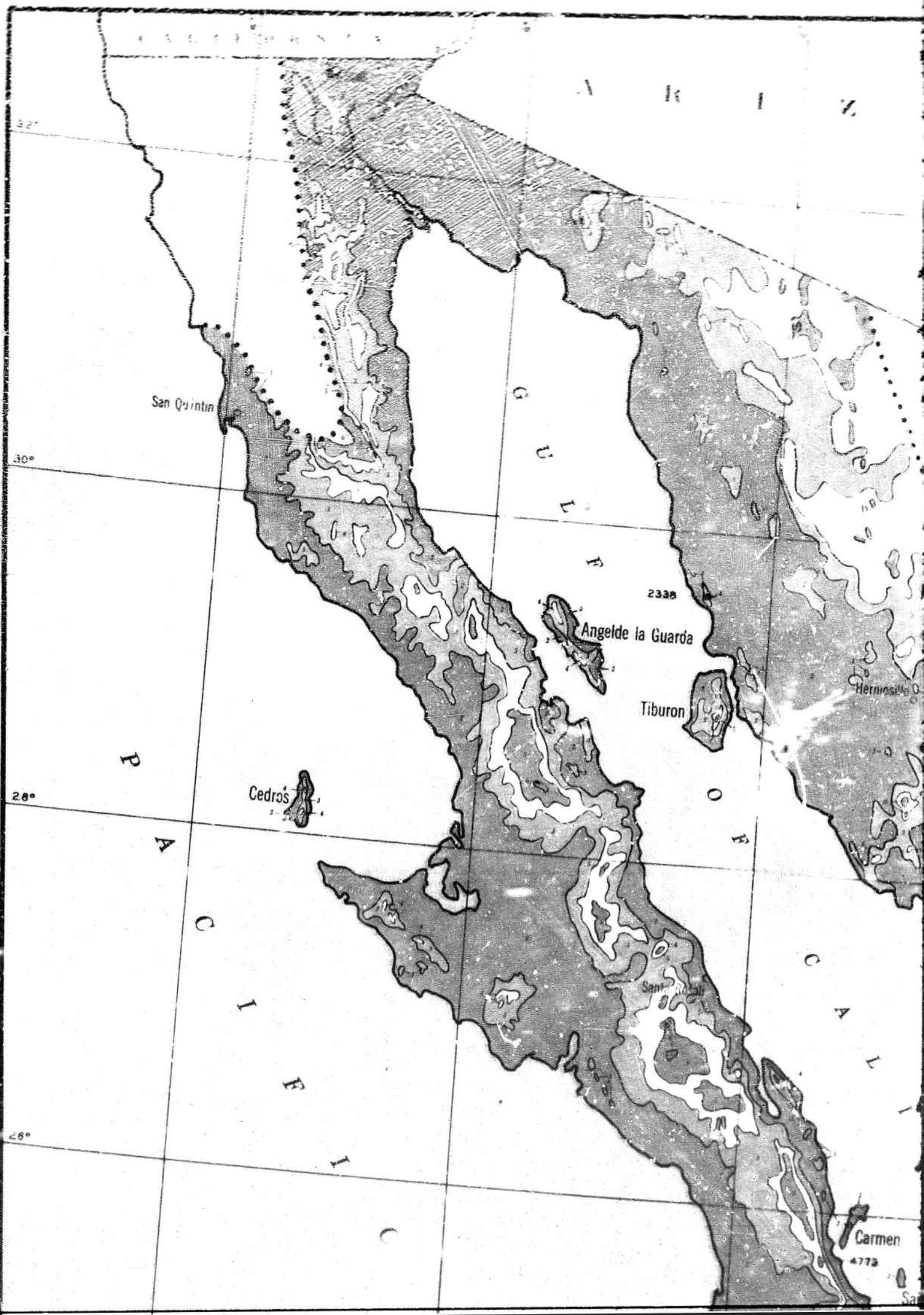
ANALOGS OF YUMA TERRAIN

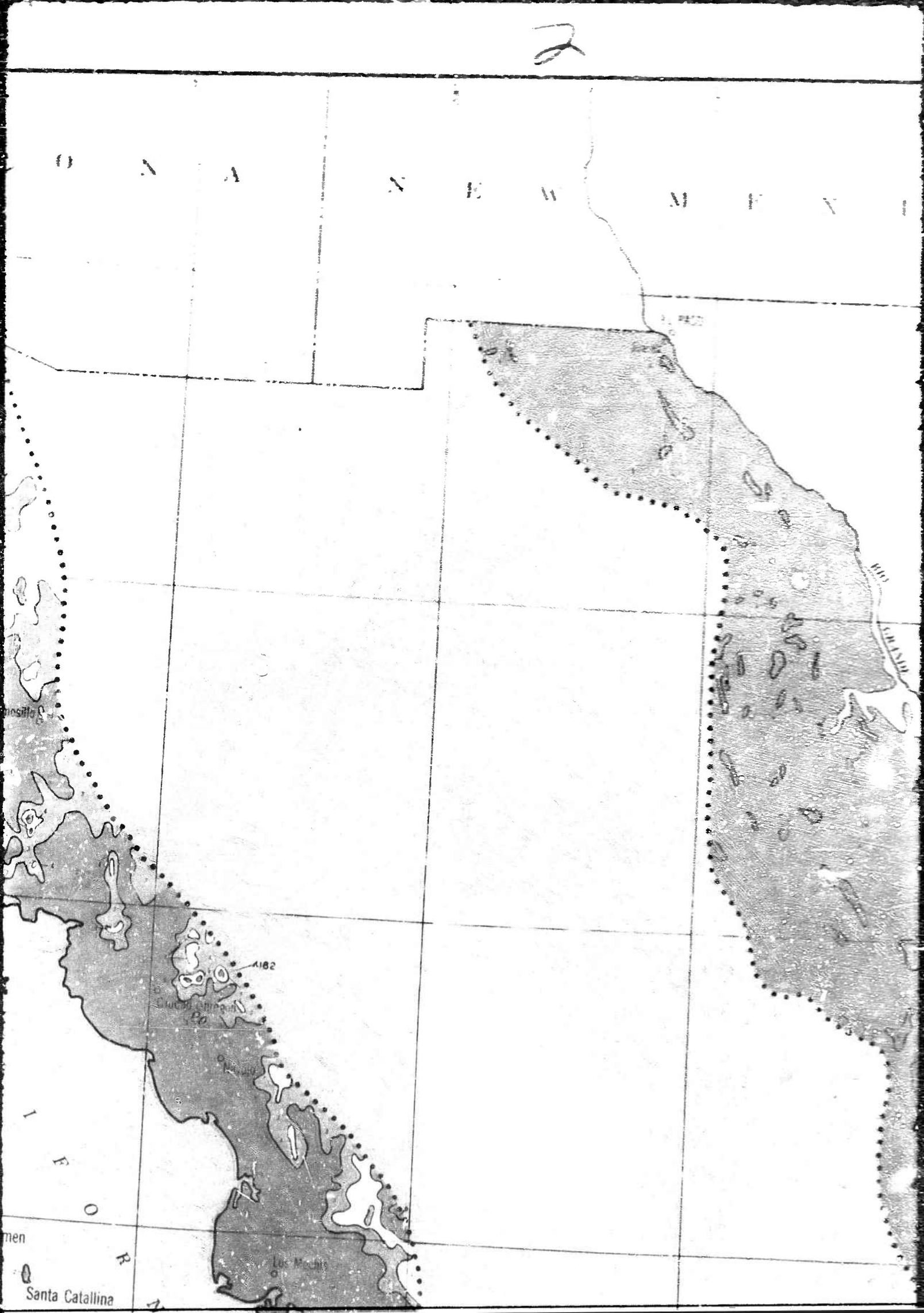
IN THE

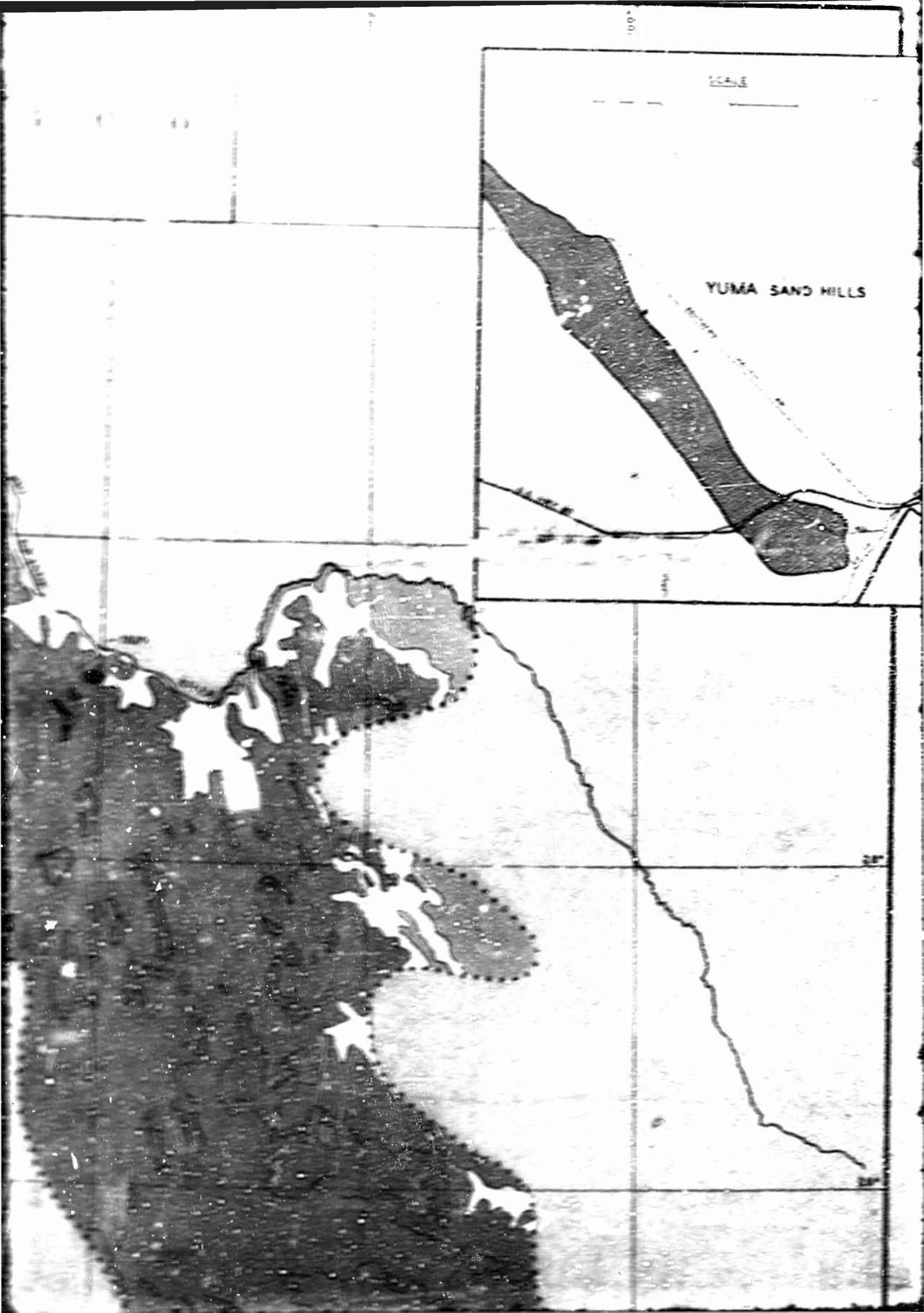
MEXICAN DESERT

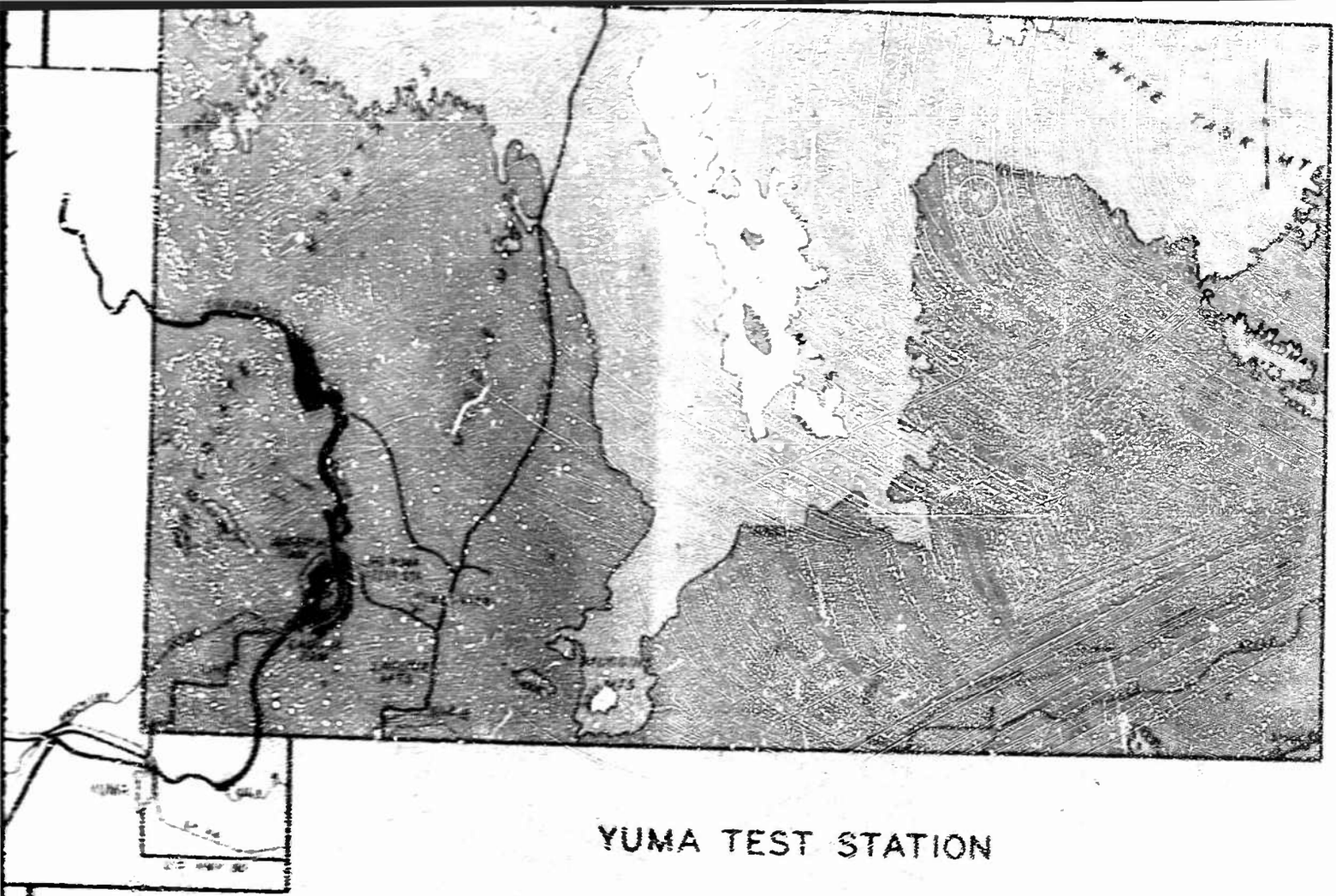
PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

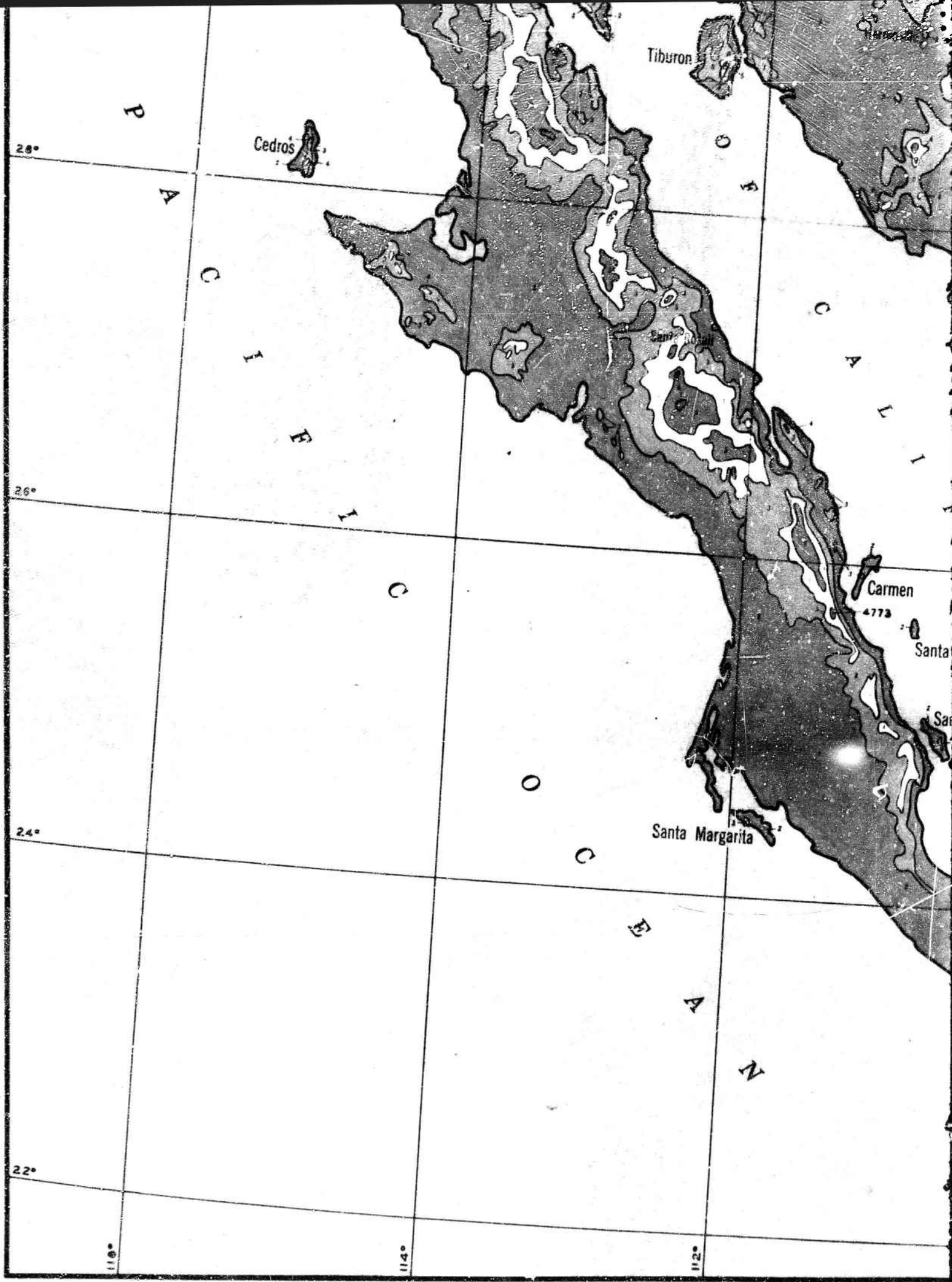

32°
30°
28°
26°
San Quintin
Angel de la Guarda
2338
Tiburon
Hermosillo
Cedros
Carmen
4773
GULF OF CALIFORNIA
PACIFIC

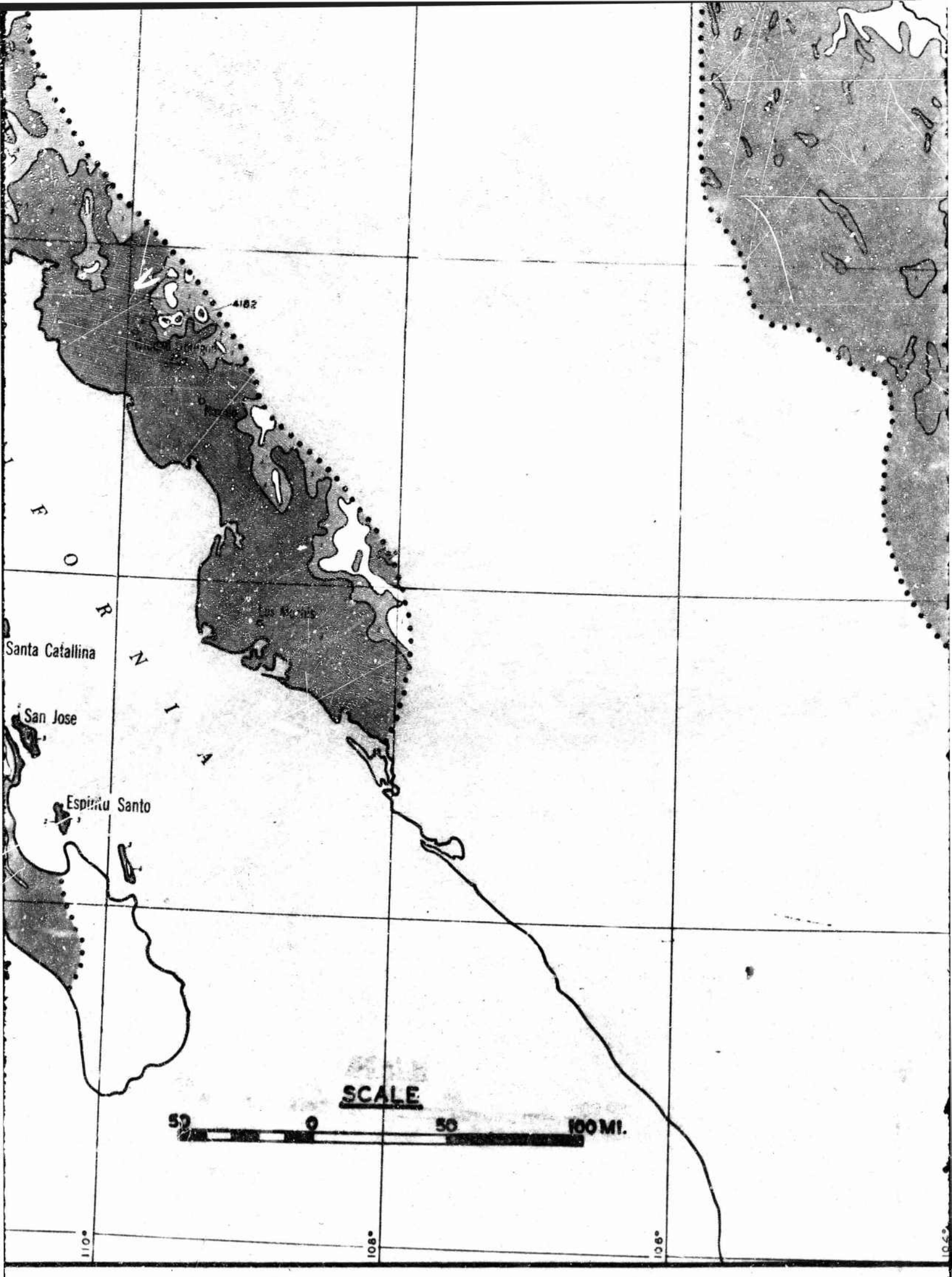

Santa Catallina

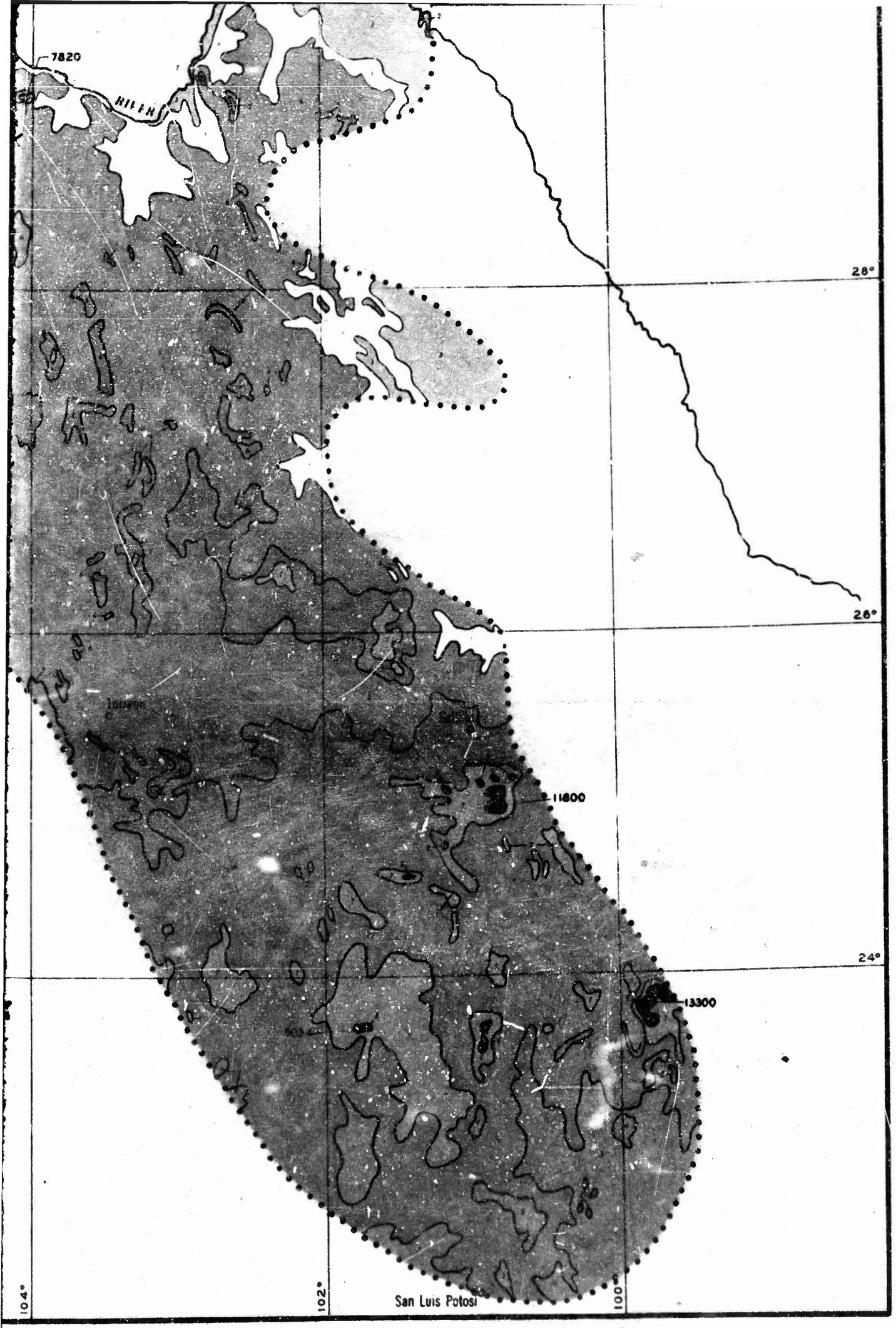

SCALE
YUMA SAND HILLS



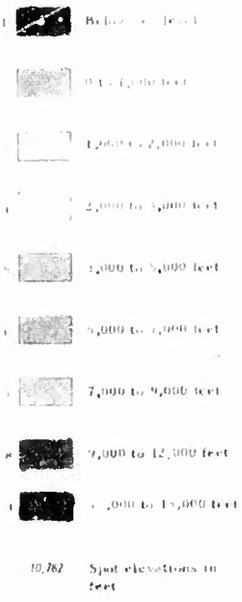
YUMA TEST STATION


Tiburon
Cedros
Carmen
4773
Santa Margarita
28°
26°
24°
22°
118°
114°
112°
PACIFIC OCEAN
GULF OF CALIFORNIA


4182
Santa Catallina
San Jose
Espiritu Santo
SCALE
50 0 50 100 MI.
110°
108°
106°


7820
28°
26°
11800
24°
13300
104°
102°
100°
San Luis Potosi

EXPLANATION



Below sea level

0 to 1,000 feet

1,000 to 2,000 feet

2,000 to 3,000 feet

3,000 to 5,000 feet

5,000 to 7,000 feet

7,000 to 9,000 feet

9,000 to 12,000 feet

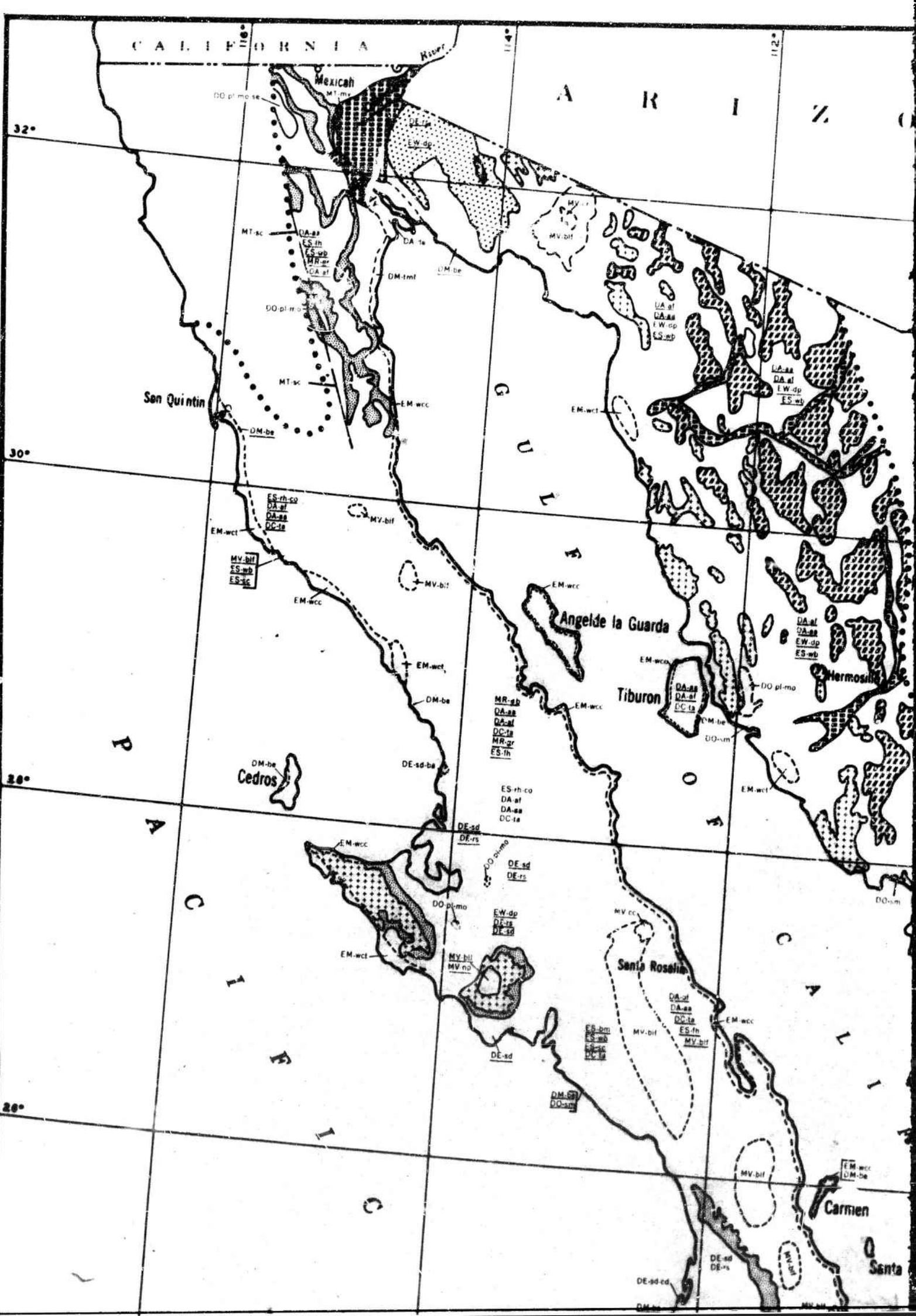
12,000 to 15,000 feet

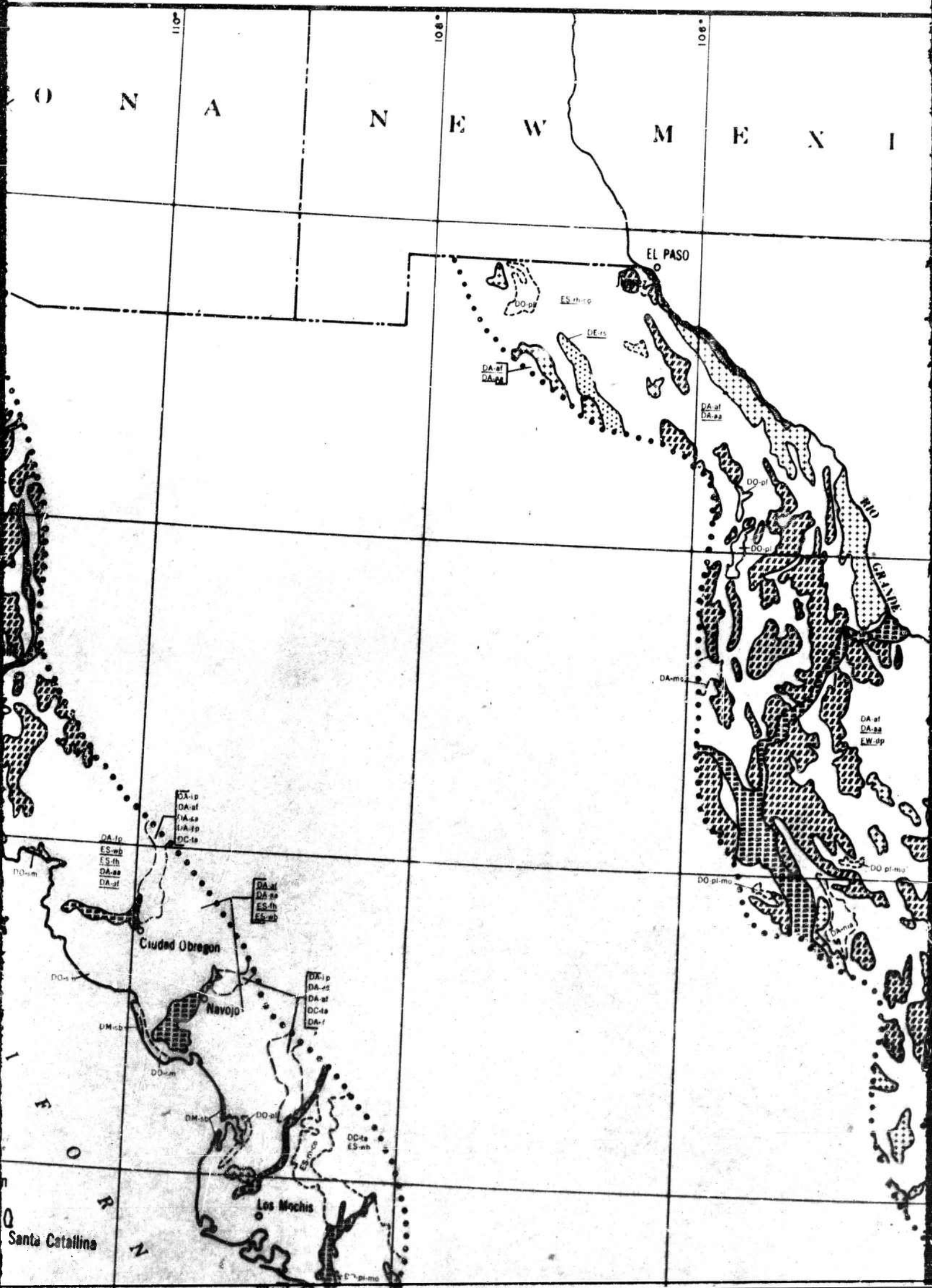
10,782 Spot elevations in feet

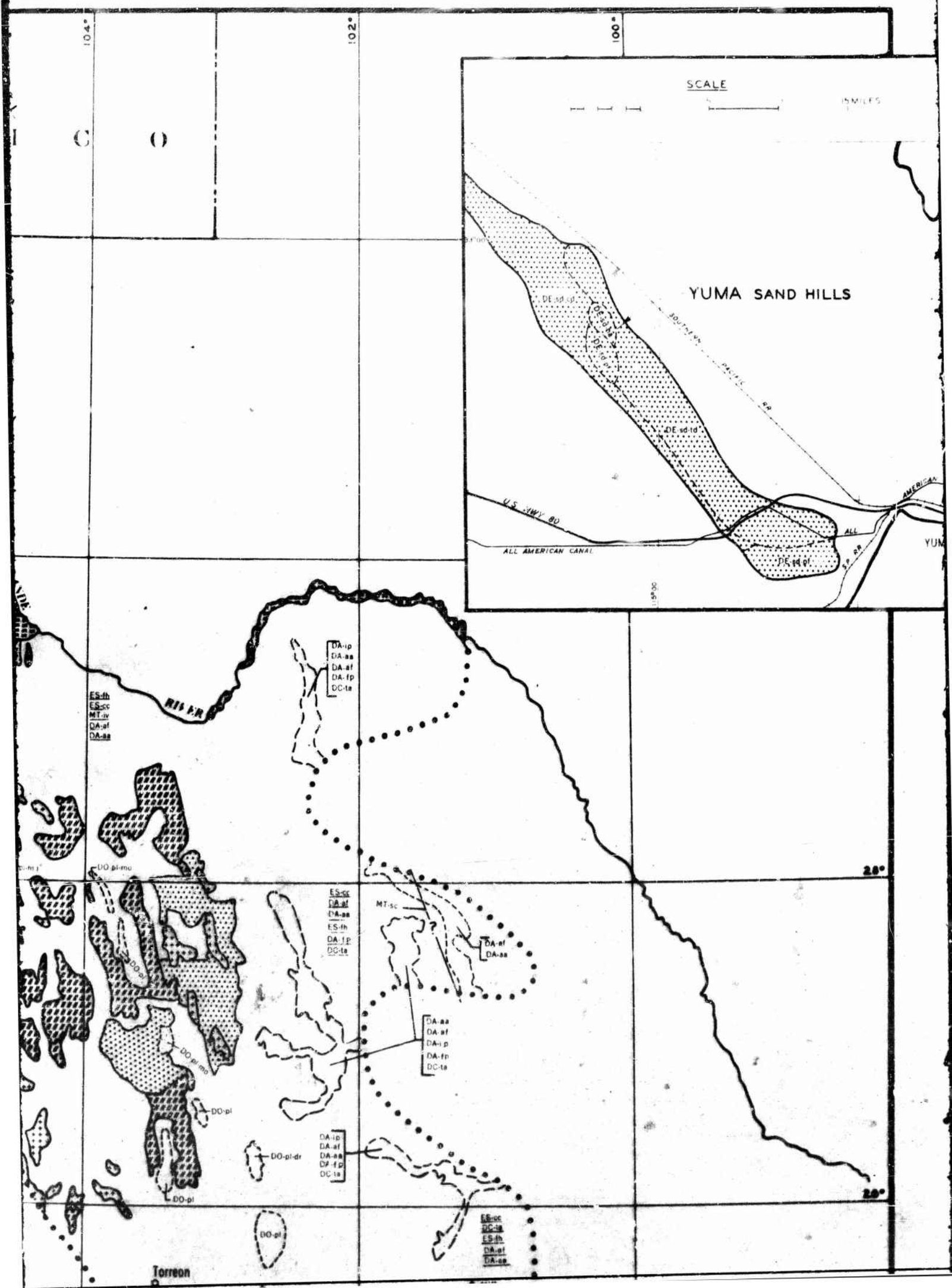
ANALOGS OF YUMA TERRAIN IN THE MEXICAN DESERT

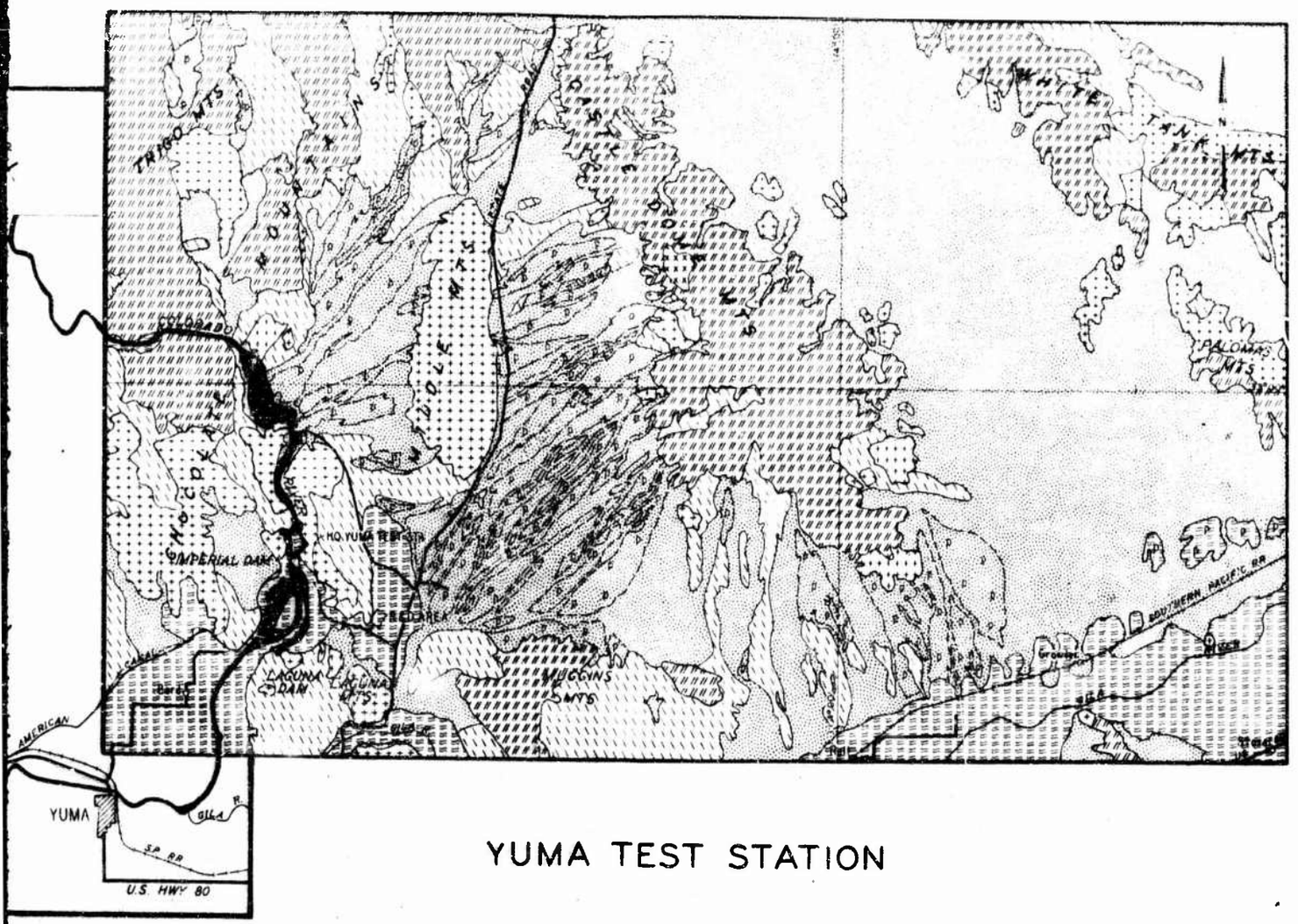
HYPSOMETRY

PLATE 16


CALIFORNIA
ARIZ
Mexican
32°
30°
28°
San Quintin
Angel de la Guarda
Tiburon
Cedros
Santa Rosalia
Hermosillo
Carmen
Santa
GULF OF CALIFORNIA
PACIFIC OCEAN
DO-pl-mo-se
MT-mx
DE-fa
EW-dp
MT-sc
DA-aa
ES-th
ES-wb
MR-gr
DA-af
DA-fa
DM-tmf
DM-be
DO-pl-mo
EM-wcc
EM-wct
UA-af
DA-aa
EW-dp
ES-wb
ES-rh-co
DA-af
DA-aa
DC-fa
MV-bif
ES-wb
ES-sg
MR-gb
DA-aa
DA-af
DC-fa
MR-gr
ES-th
DE-sd-ba
DE-sd
DE-rs
DO-pl-mo
EW-dp
DE-rs
DE-sd
MV-bil
MV-np
MV-cc
DA-af
DA-aa
DC-fa
ES-th
MV-bif
ES-bm
ES-wb
ES-sg
DC-fa
DM-gb
DO-arm
DE-sd-cd
DO-sm


O N A
N E W M E X I
EL PASO
RIO GRANDE
Ciudad Obregon
Navojo
Los Mochis
Santa Catalina
DO-pl
ES-th-sp
DE-rs
DA-af
DA-aa
DO-pl-mo
DA-ms
DA-ip
DA-af
DA-aa
ES-wb
ES-th
DC-te
DM-sb
DO-rs
EW-dp


104°
102°
100°
28°
28°
SCALE
5 0 5 MILES
YUMA SAND HILLS
DE-sd-sl
DE-sd-ld
DE-sd-pl
SOUTHERN PACIFIC RR
U.S. HWY 80
ALL AMERICAN CANAL
AMERICAN
ALL
S.P. RR
YUM
RIO BRAVO
ES-th
ES-cc
MT-iv
DA-af
DA-aa
DA-ip
DA-aa
DA-af
DA-fp
DC-ta
DO-pl-mo
DO-pl
DO-pl-dr
ES-cc
DA-af
DA-aa
ES-th
DA-fp
DC-ta
MT-sc
DA-af
DA-aa
DA-aa
DA-af
DA-ip
DA-fp
DC-ta
DA-ip
DA-af
DA-aa
DA-fp
DC-ta
ES-cc
DC-ta
ES-th
DA-af
DA-aa
Torreon



YUMA TEST STATION

SELECTED LANDFORMS AND SURFACE CONDITIONS

I. DEPOSITIONAL

ALLUVIAL

- Alluvial fans ..... DA-af
- Alluvial aprons ..... DA-aa
- Flood plains ..... DA-fp
- River terraces ..... DA-rt
- Deltas ..... DA-de
- Marsh ..... DA-ma
- Intermontane plains ..... DA-ip

COLLUVIAL

- Talus ..... DC-ta

EOLIAN

- Sand dunes (undiff.) ..... DE-sd
  - Barchans ..... DE-sd-ba
  - Peaks and fulgi ..... DE-sd-pf
  - Transverse dunes ..... DE-sd-td
  - Complex dunes ..... DE-sd-cd
- Rippled surfaces ..... DE-rs

MARINE

- Beaches ..... DM-be
- Tidal mud flats ..... DM-tmf

ORGANIC-CHEMICAL

- Playas (sabkhas & khabras) (undiff.) ..... DO-pl
  - Dry ..... DO-pl-dr
  - Moist ..... DO-pl-mo
    - Salt encrusted ..... DO-pl-mo-se
    - Clay encrusted ..... DO-pl-mo-ce
- Salt marsh ..... DO-sm

II. EROSIONAL

SURFACE WATER

- Badlands ..... ES-bl
- Buttes and mesas ..... ES-bm
- Canyon country ..... ES-cc
- Foothills ..... ES-fh

WIND

- Desert pavements (undiff.) ..... EW-dp

MARINE

- Wave-cut cliffs ..... EM-wcc
- Wave-cut terraces ..... EM-wct

III. MISCELLANEOUS

VOLCANIC

- Cinder cones ..... MV-cc
- Craters and calderas ..... MV-cr
- Broken lava flows ..... MV-bl
- Necks and plugs ..... MV-np

TECTONIC

- Basin ranges ..... MT-br
- Scarps ..... MT-sc
- Intermontane valleys ..... MT-iv
- Mud volcanoes ..... MT-mv

RESIDUAL

- Grus ..... MR-gr
- Exfoliated boulders ..... MR-eb

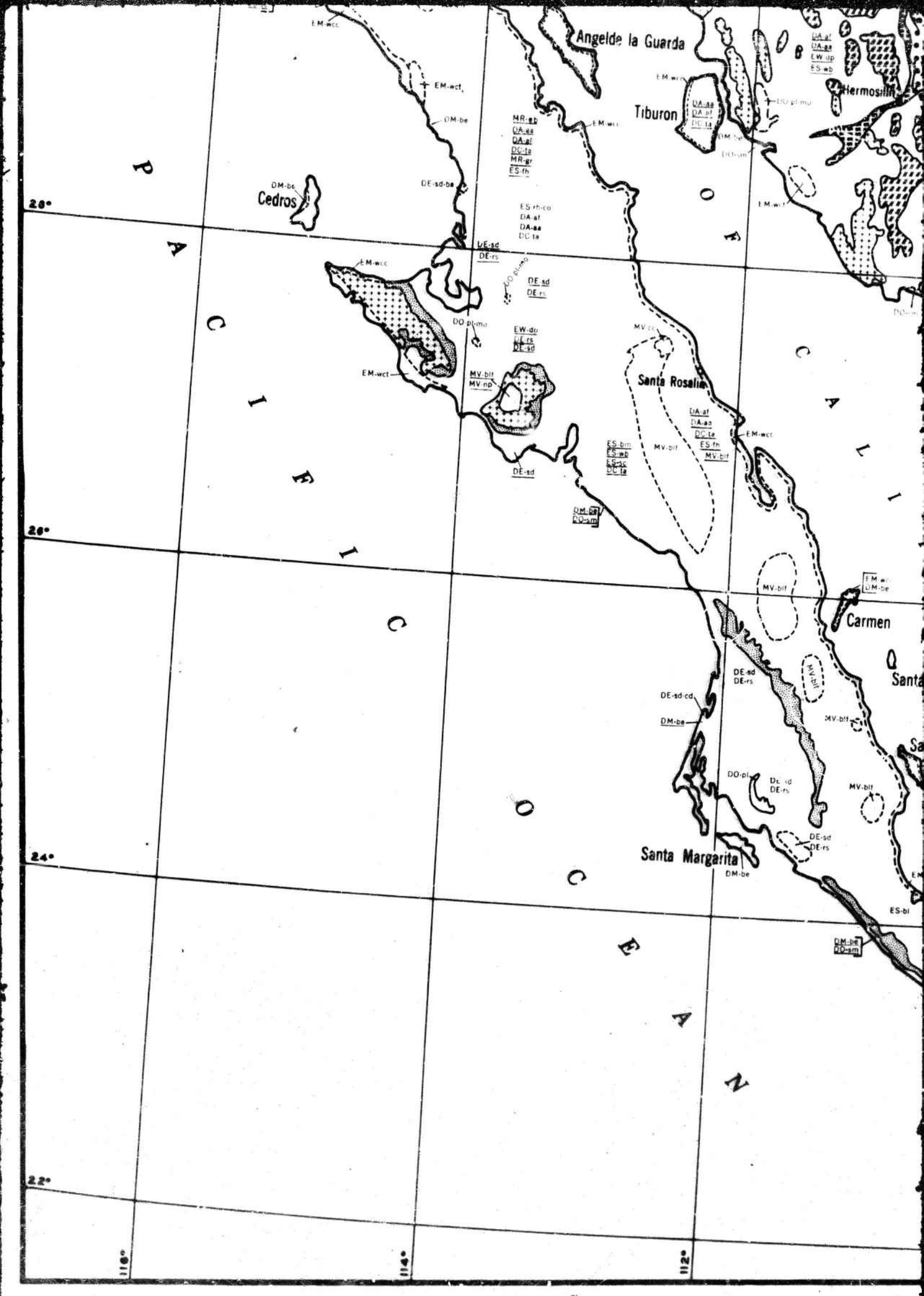
INTRUSIVE

- Dikes ..... MI-di

*The patterned overprint used on the maps has been restricted to those landforms which occur at Yuma. Areas so delineated in the Mexican desert indicate regions within which the particular landform predominates.

(ES-bl) or DA-de — Indicates the general area in which a specific landform or surface condition is known to exist.

Indicates that this feature is common


Angel de la Guarda
Tiburon
Hermosillo
Cedros
Santa Rosalia
Carmen
Santa Margarita
PACIFIC OCEAN
CALIFORNIA
28°
26°
24°
22°
114°
112°
EM-wct
DM-be
DE-sd-ba
MR-gp
DA-aa
DA-af
DC-te
MR-gr
ES-fh
ES-rh-co
VE-sd
DE-rs
DO-pl-mo
DE-sd
EW-dp
MV-bff
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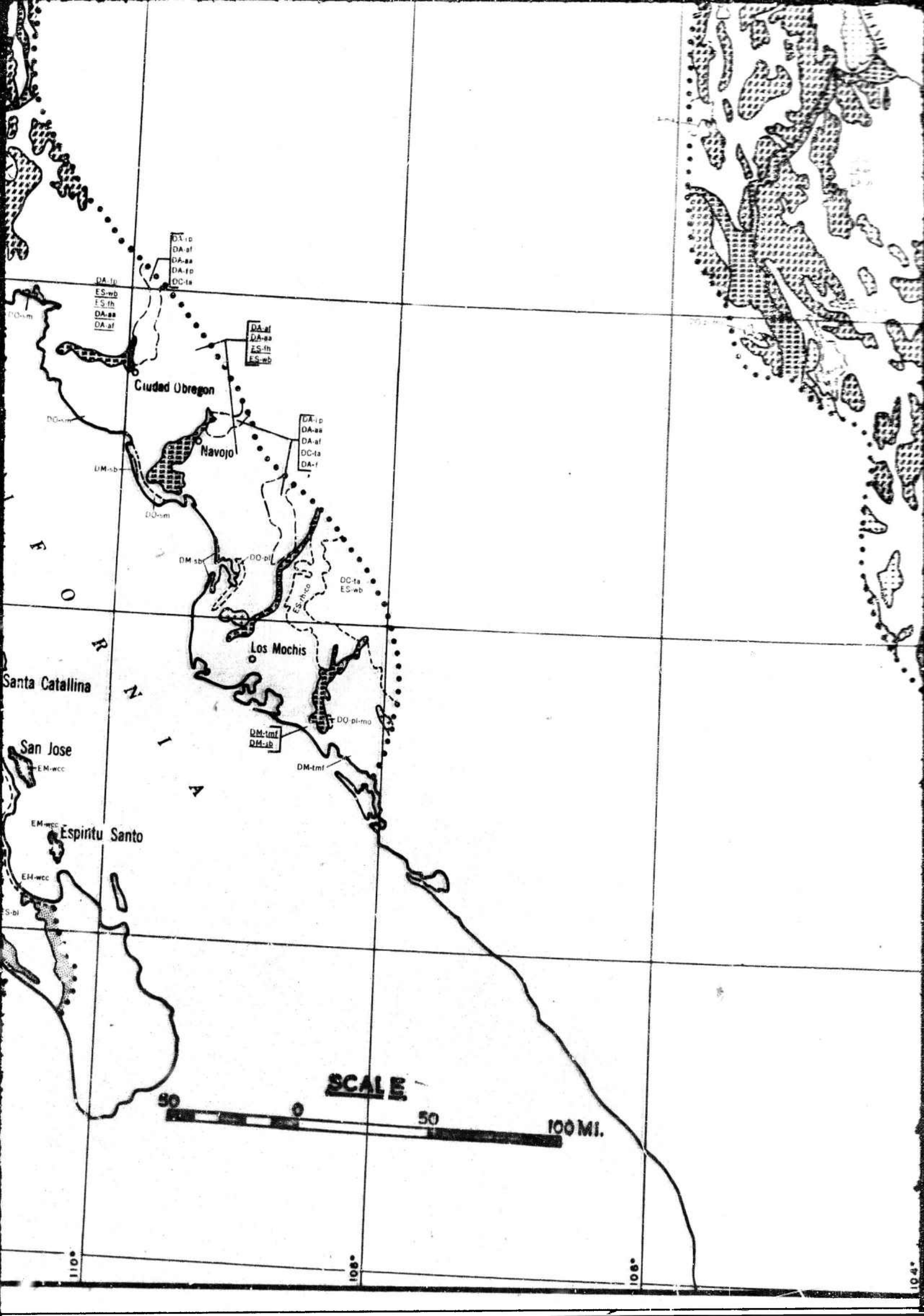
ES-wb
ES-sg
DM-pe
DO-sm
MV-bff
DE-sd-cd
DO-pl
ES-bl


Ciudad Obregon
Navojo
Los Mochis
Santa Catallina
San Jose
Espiritu Santo
SCALE
50
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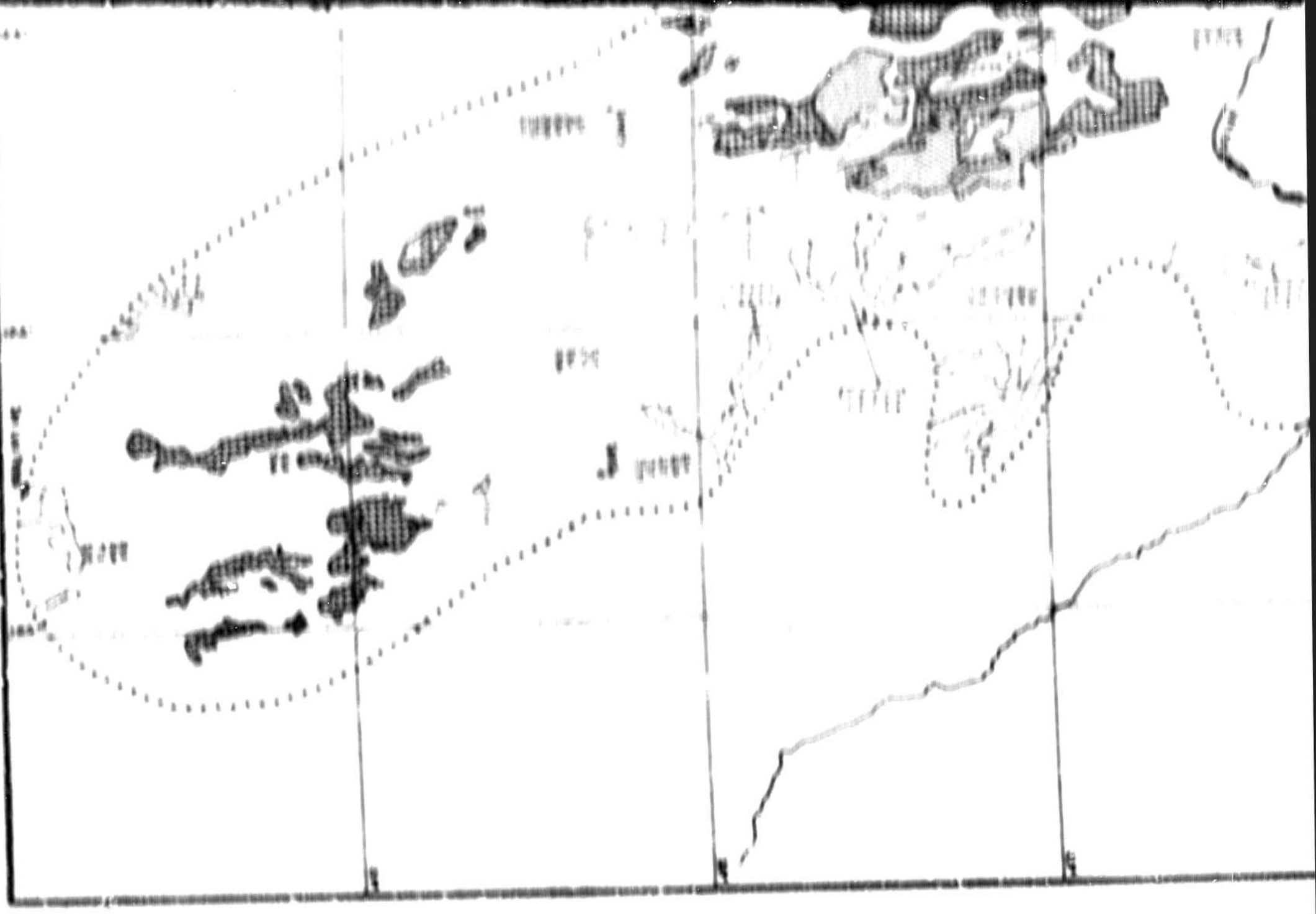
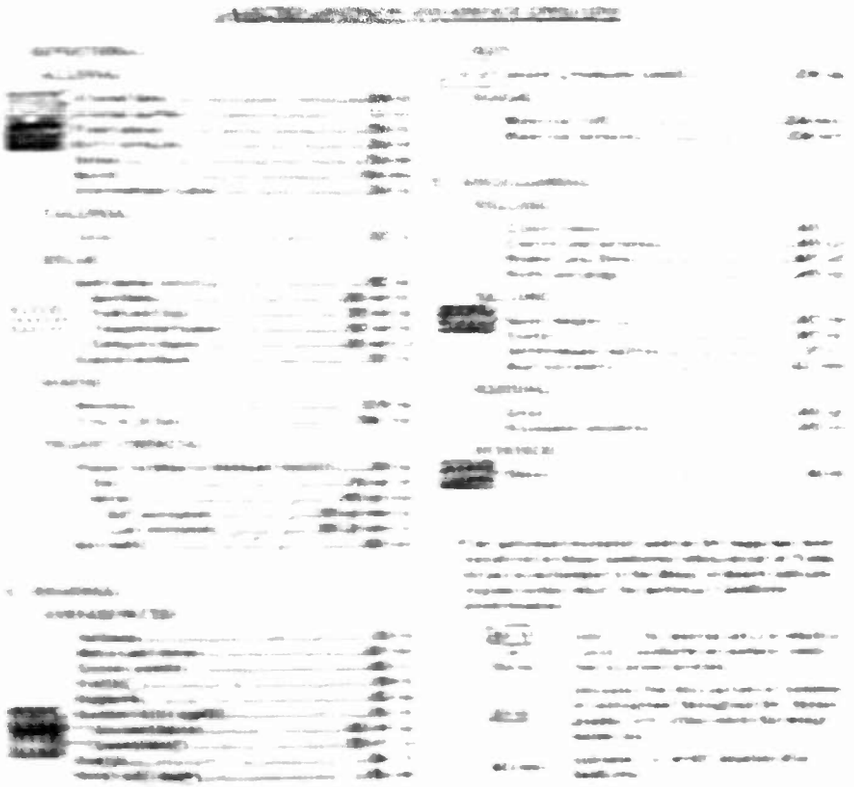
100 Mi.
110°
108°
106°
104°





ANALOGS OF YUMA TERRAIN
IN THE
MEXICAN DESERT

SELECTED LANDFORMS AND SURFACE CONDITIONS

6

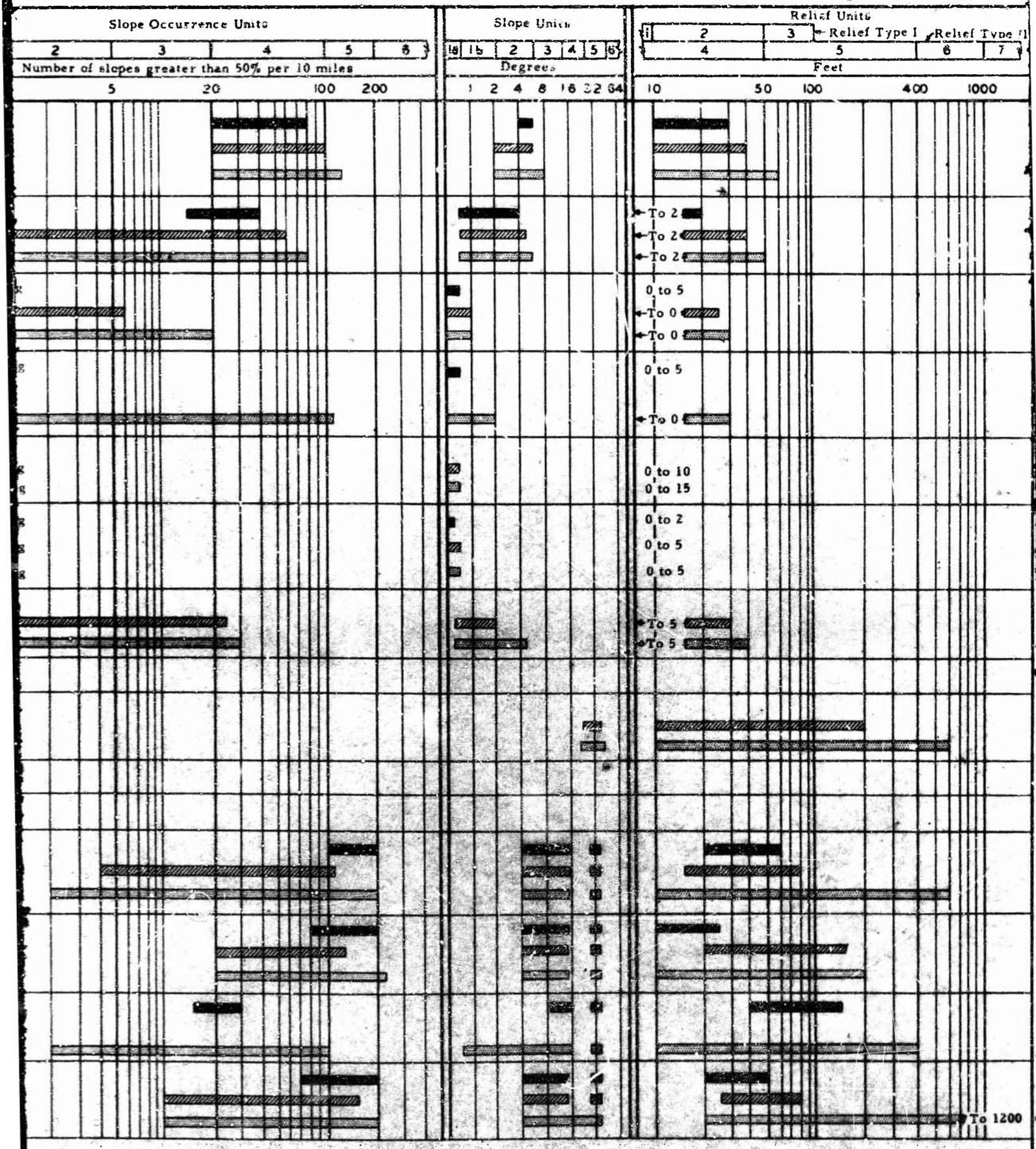
PLATE 18

Photo No.	CLASSIFICATION AND DESCRIPTION	Plan-Profile Units	Range at; 1 2 Number
	1. DEPOSITIONAL		
	ALLUVIAL		
1	Alluvial fans: Alluvial fans are cone-shaped features occurring at the base of mountains, hills, escarpments, etc., where streams experience a sufficient reduction in gradient to deposit their loads. These fans, steepest near the mountains, slope gently outward with a continually decreasing gradient and are characterized by braided stream channels which score their surfaces.	1L 1L 1L	
2	Alluvial aprons: Alluvial aprons are created through coalescence of alluvial fans along the base of mountains or plateau escarpments. Several fans coalesce to form an alluvial apron.	1L, 7 1L, 7 1, 1L, 7	To 0 To 0
3	Flood plains: Flood plains are relatively smooth, flat lands bordering a stream. They are built of sediments deposited by the stream and inundated by floodwaters.	7 7, 1L 7, 1, 1L	Lacking To 0 To 0
4	River terraces: River terraces are flat strips of land bordering river flood plains. They are characterized by a sharp descent toward the river and by more elevated land on the opposite side. A steplike arrangement of several terraces often flanks large flood plains.	7 7, 1	Lacking To 0
5	Deltas: Deltas are alluvial tracts of land, usually triangular in shape, formed at the mouth of a river. Inland boundaries of deltas often, but not invariably, coincide with the farthest upstream distributaries of a river.	7 7	Lacking Lacking
6	Marsh: Marsh is a tract of land (in reference to surrounding terrain), wet ground, usually miry and covered with rank grass and sedge vegetation and confined to fresh-water areas.	7 7 7	Lacking Lacking Lacking
7	Intermontane plains: Basins of interior drainage between mountain ranges composed of fine-grained alluvium deposited by streams issuing from the adjacent mountains.	7, 1L 7, 1, 1L	To 0 To 0
	COLLUVIAL		
8	Talus: Talus is an unconsolidated, sloping heap of fairly large rock fragments or debris formed at the base of an escarpment or steep slope through gravitational accumulation.	NA NA	NA NA
	EOLIAN		
	Sand dunes: Mobile heaps of wind-blown sand independent of fixed objects or underlying topography.		
9	Barchans: Barchans are dunes having a crescentric ground plan with the convex side facing the wind and horns extending leeward. The profile is asymmetric with the gentler slope on the convex side and the steeper slope on the concave or leeward face.	6 4, 6 4, 5, 6	
10	Peak and fuji: These occur where the tips or horns of a [illegible] barchan join or intersect the windward side of another barchan, thus forming a circular or horseshoe-shaped hollow known as a fuji. The crest of the barchan slip face which flanks the fuji is referred to as the peak.	4 4, 4L 4, 4L	
11	Transverse dunes: Transverse dunes are strongly asymmetric ridges extending transverse to the direction of dominant sand-moving winds. The leeward slope is steep; the windward, comparatively gentle.	4L// 4L, 5L, 6L, 4L//, 5L//, 6L//	
12	Complex dunes: Complex dunes are irregular masses of sand not readily classifiable into types.	4 4 4, 4L	
13	Rippled surfaces: Washboardlike surfaces caused by the heaping up of sand by wind action. They are normally found on the gentler slopes of dunes or in flat, sandy areas.	This phenomenon is classed as a surface c 1 or 2 inches to 3 feet and are spaced at in	
	MARINE		
14	Beaches: Beaches are gently sloping strips of land bordering the sea, usually recognized as that part which lies between high and low watermarks, and formed by the action of the sea.	7 7	Lacking Lacking
15	Tidal mud flats: Marshy or muddy lands covered and uncovered by the rise and fall of the tide.		

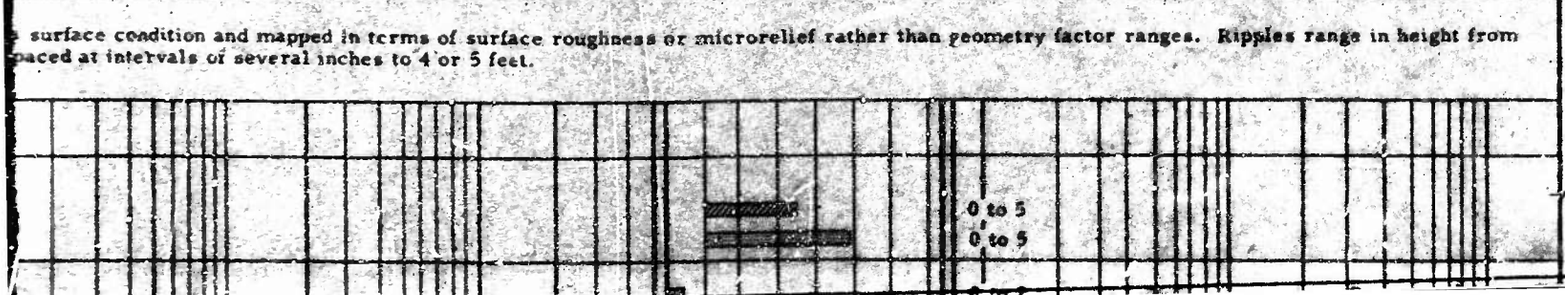
LANDFORMS–SURFACE CONDITIONS: DESCRIPTIONS AND

TYPICAL GEOMETRY FACTOR RANGES

Range at Yuma ▨ Range in the Mexican Desert ▭ World-wide Range



surface condition and mapped in terms of surface roughness or microrelief rather than geometry factor ranges. Ripples range in height from spaced at intervals of several inches to 4 or 5 feet.



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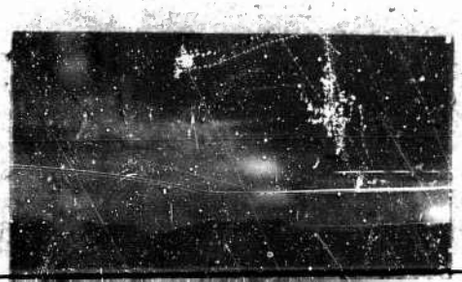

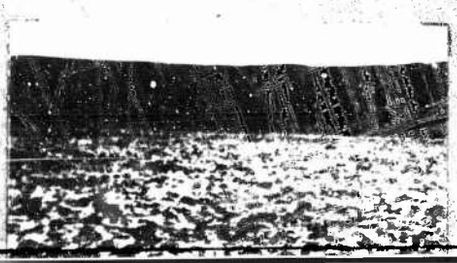

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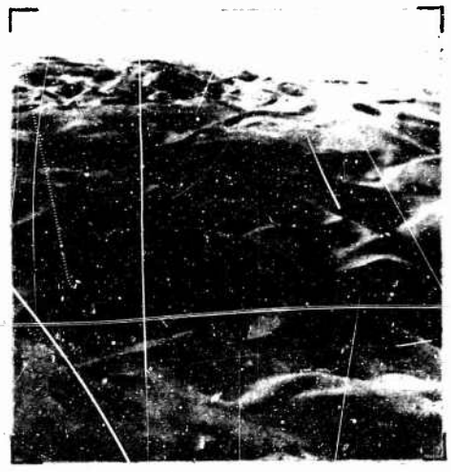

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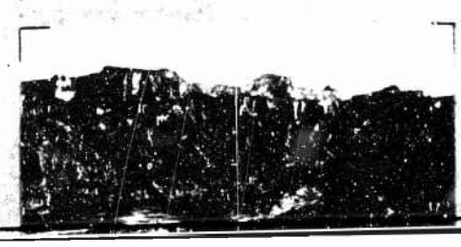
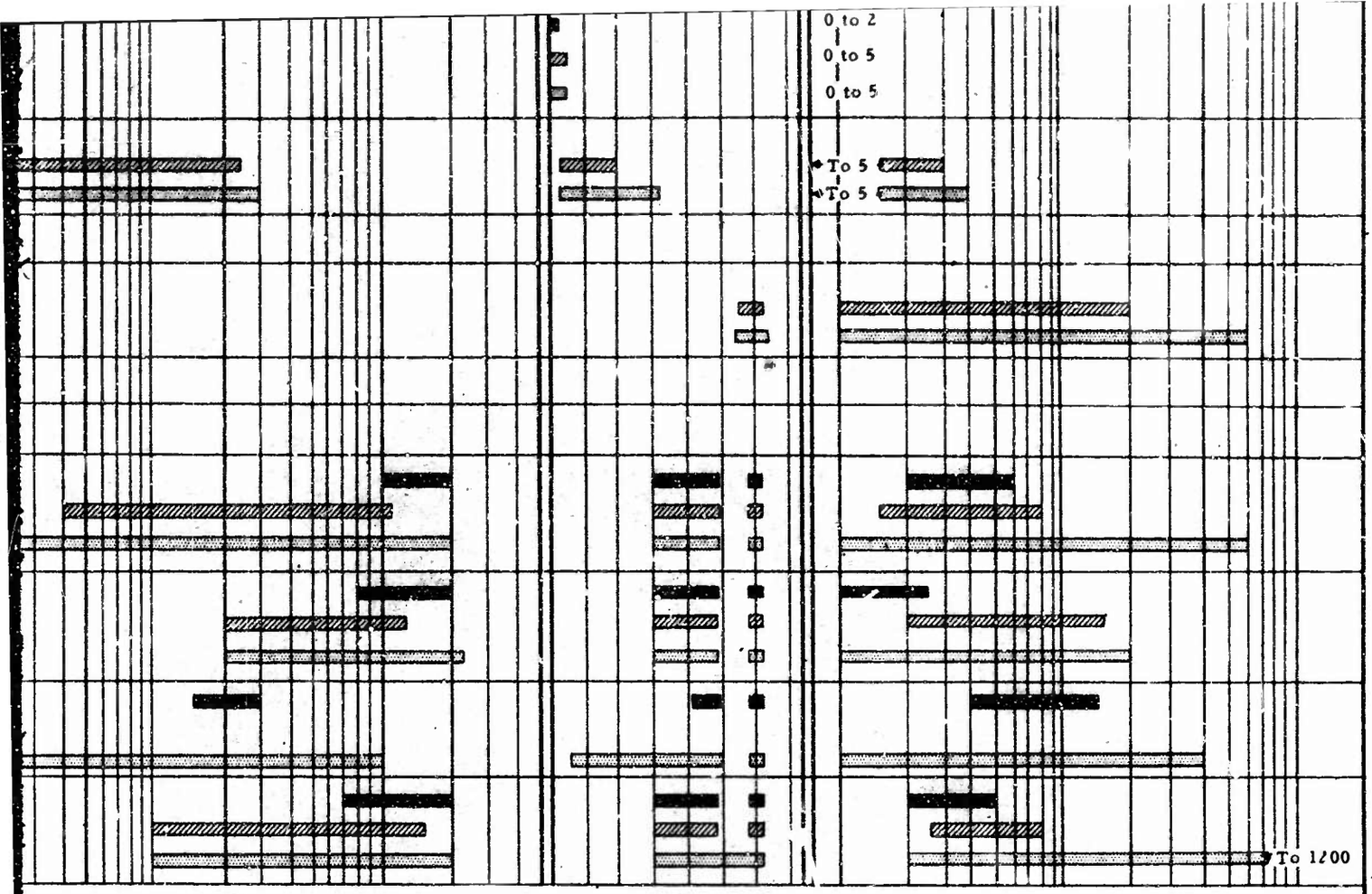
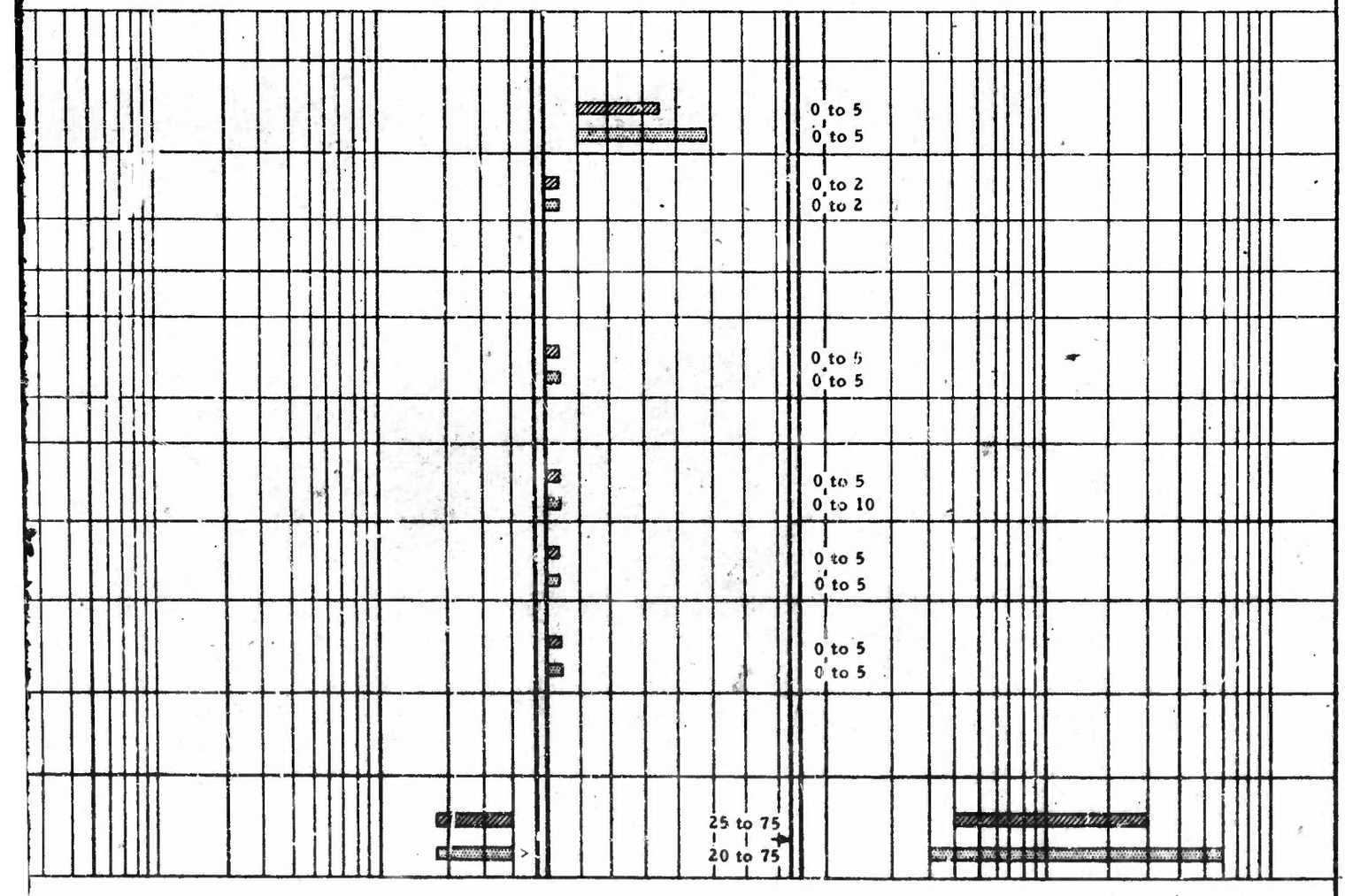


	usually miry and covered with rank grass and sedge vegetation and confined to fresh-water areas.	7 7	Lacking Lacking
7	Intermontane plains: Basins of interior drainage between mountain ranges composed of fine-grained alluvium deposited by streams issuing from the adjacent mountains.	7, 1L 7, 1, 1L	←To 0 ←To 0
	COLLUVIAL		
8	Talus: Talus is an unconsolidated, sloping heap of fairly large rock fragments or debris formed at the base of an escarpment or steep slope through gravitational accumulation.	*NA NA	NA NA
	EOLIAN		
	Sand dunes: Mobile heaps of wind-blown sand independent of fixed objects or underlying topography.		
9	Barchans: Barchans are dunes having a crescentric ground plan with the convex side facing the wind and horns extending leeward. The profile is asymmetric with the gentler slope on the convex side and the steeper slope on the concave or leeward face.	4 4, 6 4, 5, 6	
10	Peak and fulji: These occur where the tips or horns of a fast-moving barchan join or intersect the windward side of another barchan, thus forming a circular or horseshoe-shaped hollow known as a fulji. The crest of the barchan slip-face which flanks the fulji is referred to as the peak.	4 4, 4L 4, 4L	
11	Transverse dunes: Transverse dunes are strongly asymmetric ridges extending transverse to the direction of dominant sand-moving winds. The leeward slope is steep; the windward, comparatively gentle.	4L// 4L, 5L, 6L, 4L//, 5L//, 6L//	
12	Complex dunes: Complex dunes are irregular masses of sand not readily classifiable into types.	4 4 4, 4L	
13	Rippled surfaces: Washboardlike surfaces caused by the heaping up of sand by wind action. They are normally found on the gentler slopes of dunes or in flat, sandy areas.	This phenomenon is classed as a surface c 1 or 2 inches to 3 feet and are spaced at in	
	MARINE		
14	Beaches: Beaches are gently sloping strips of land bordering the sea, usually recognized as that part which lies between high and low watermarks, and formed by the action of the sea.	7 7	Lacking Lacking
15	Tidal mud flats: Marshy or muddy lands covered and uncovered by the rise and fall of the tide.	7 7	Lacking Lacking
	ORGANIC-CHEMICAL		
	Playas: Playas are nearly flat areas of salt or salty fine-grained soils occupying basins where water collects and evaporates after moderate o orrential rains.		
16	Dry playas: Dry playas are characterized by very hard, smooth, flat surfaces of fine-grained soil.	7 7	Lacking Lacking
	Moist playas: Moist playas are characterized by irregular, puffy surfaces with a thin friable surface crust which is underlain by soft, spongy ground.		
17	Salt-encrusted: Salt-encrusted playas are moist playas with a surface crust of salt.	7 7	Lacking Lacking
18	Clay-encrusted: Clay-encrusted playas are moist playas with a surface crust of clay.	7 7	Lacking Lacking
19	Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces are so near the level of the mean high tide that they are covered by the majority of high tides.	7 7	Lacking Lacking
	II. EROSIONAL SURFACE WATER		
20	Badlands: Regions nearly devoid of vegetation where erosion, instead of carving hills and valleys of the ordinary type, has cut the land into an intricate maze of narrow ravines, sharp crests, and pinnacles.	4 4	

* Not applicable.



ce condition and mapped in terms of surface roughness or microrelief rather than geometry factor ranges. Ripples range in height from
t intervals of several inches to 4 or 5 feet.



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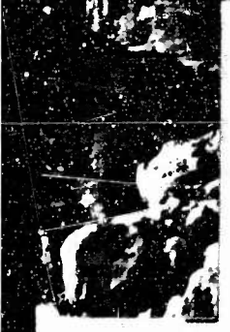

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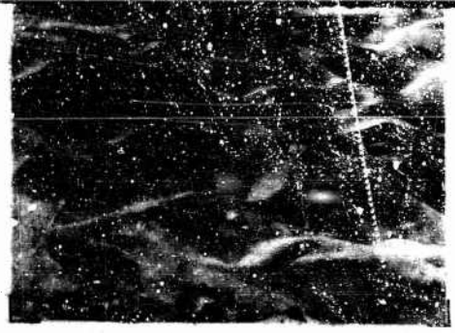

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ANALOGS OF YUMA TERRAIN

IN THE

MEXICAN DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION	Plan-Profile Units	Range at — Number: 1 — 2
	II. EROSIONAL (Cont'd)		
	SURFACE WATER		
	Random hills: Randomly oriented masses rising less than 1000 feet above the level of the surrounding country.		
21	Unconsolidated random hills: Consist of unconsolidated material such as clay, silt, sand, or gravel.	4 4, 4L	
22	Consolidated random hills: Consist of masses of sedimentary, igneous, or metamorphic rock.	4 4 4, 4L	
23	Buttes and mesas: Isolated residual prominences with very steep or precipitous slopes left as erosional remnants of a plateau area. Mesas have distinctively flat tops; buttes have been so eroded that only small, flat tops or peaks remain.	†(3) (2, 3, 5, 6)	
24	Foothills: Foothills are lower subsidiary hills at the foot of mountains or higher hills. They form transitional zones between the highlands and the adjacent lower land.	4 4, 4L	
25	Canyon country: Canyon country refers to a plateau dissected by a branching network of broad, steep-walled, flat-floored valleys.	1 1, 2, 4, 5	
26	Hogbacks: Hogbacks are sharp-crested ridges produced by unequal erosion in steeply inclined rock.	4L// (4L//, 5L//, 6L//)	
27	Scarps: Scarps are more or less continuous, precipitous slopes exhibiting more than 100 feet of relief.	*NA NA	NA NA
28	Steep wadi banks: Steep wadi banks are mapped where a conspicuous number of wadies bordered by high precipitous banks occur. Wherever banks are higher than 100 feet they are considered scarps.	1L 1, 1L, 1L//	
	WIND		
29	Desert pavements (undiff.): Desert pavement is a mosaic of closely packed pebbles and broken rock fragments usually coated with a stain or crust of manganese or iron oxide.	This phenomenon is classed as a surfac veneer of closely fitted gravel or rock f exhibit maximum diameters of several i	
	MARINE		
30	Wave-cut cliffs: Steep cliffs of bare rock, or occasionally unindurated materials, resulting from wave erosion marking the seaward limit of the coast.	NA NA	NA NA
31	Wave-cut terraces: Steplike, narrow strips of land adjacent to or near the sea which have been sculptured by the waves and current. Each terrace records a landward advance of littoral erosion.	7, 1 7, 1	0 to 10 0 to 20
	III. MISCELLANEOUS		
	VOLCANIC		
32	Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash or clinkerlike material around a vent.	4 4, 4//, 5, 5//, 6, 6//	
33	Craters and calderas: Bowl- or funnel-shaped depressions of volcanic origin which are more or less circular in plan and rimmed by an infacing scarp. Craters are commonly less than a mile in diameter, while calderas have diameters several times larger.	NA NA	NA NA
34	Broken lava flows: Flat to undulating lava areas characterized by sharp-edged rocks and boulders.	1 1, 1L	
35	Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by erosion.		

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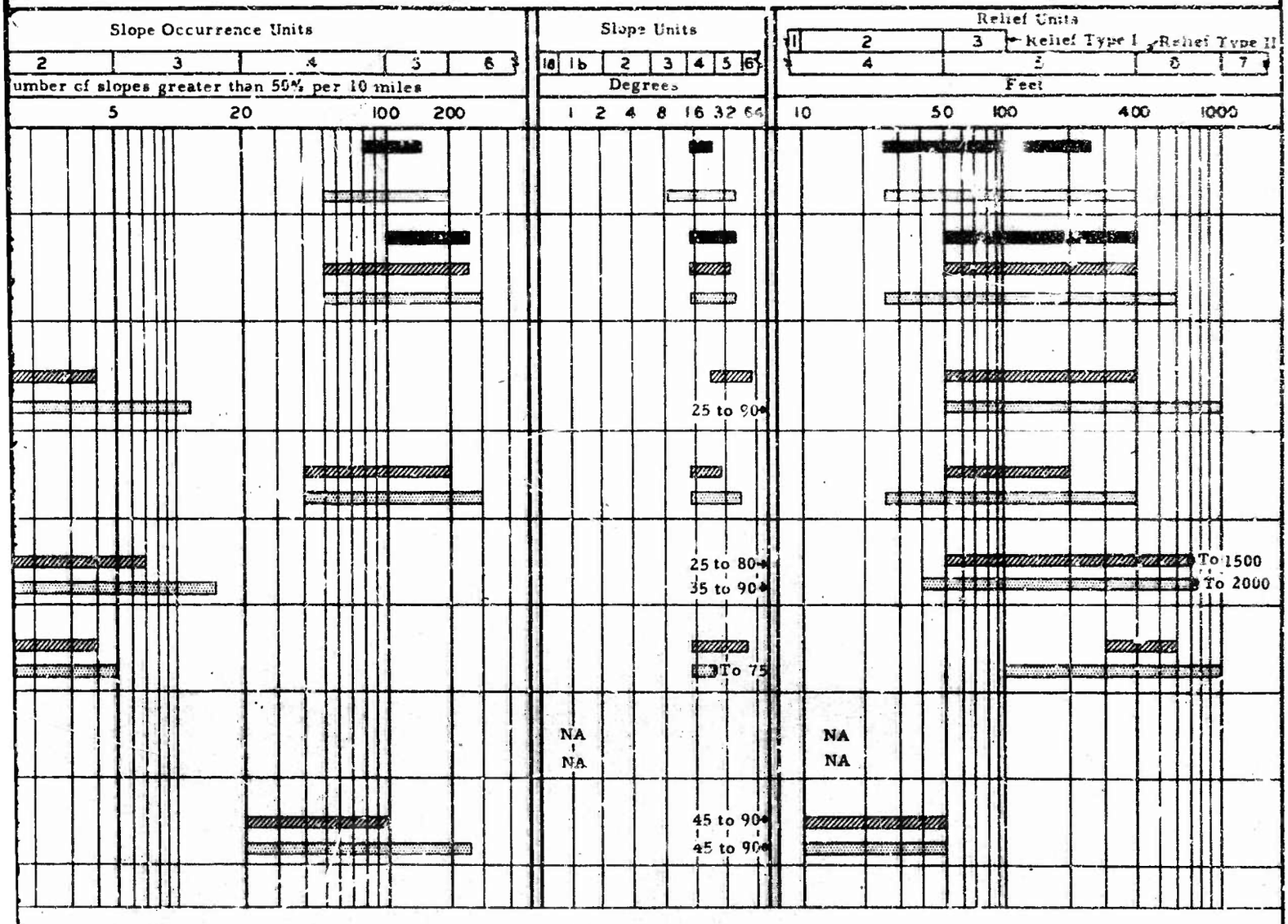
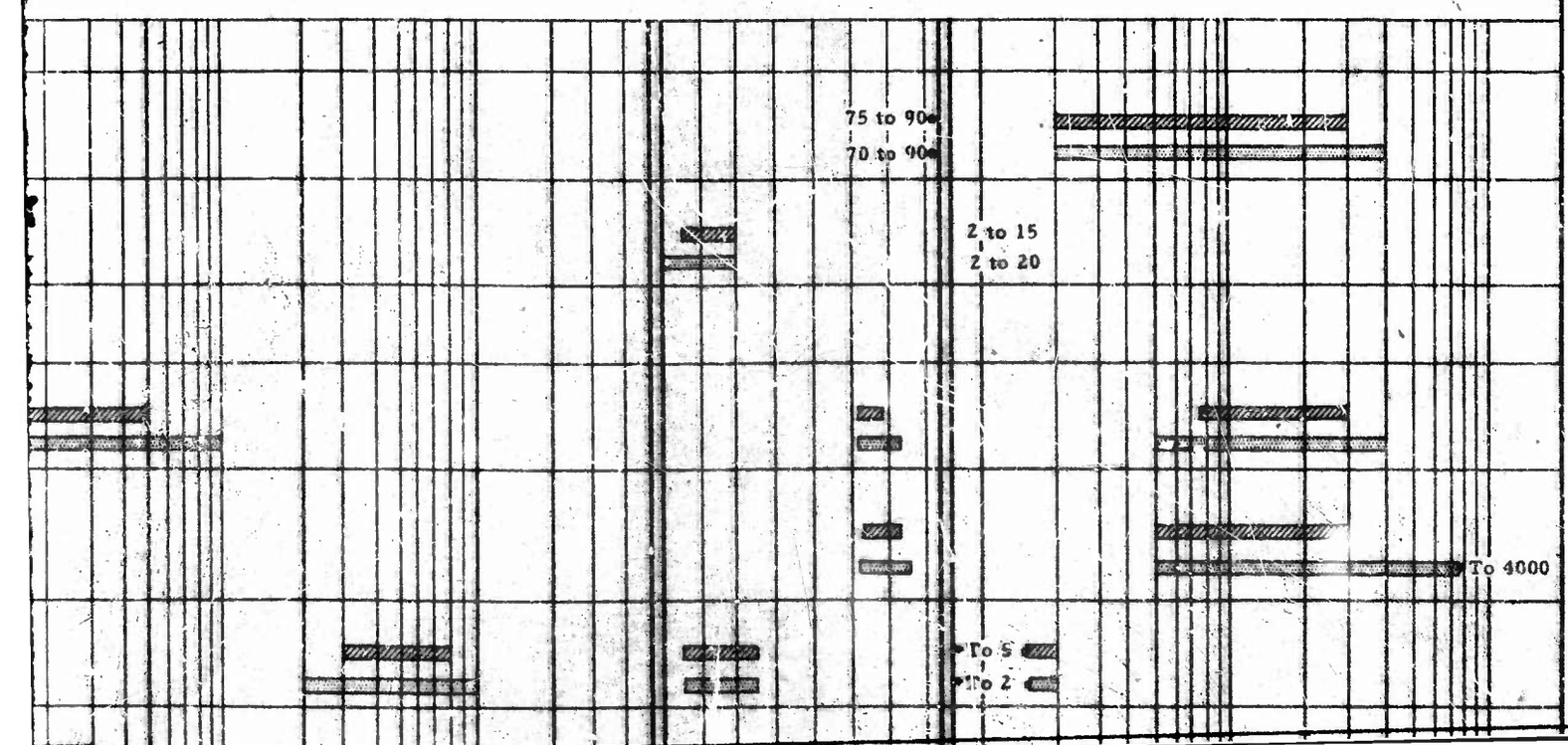
LANDFORMS–SURFACE CONDITIONS: DESCRIPTIONS AND P

TYPICAL GEOMETRY FACTOR RANGES

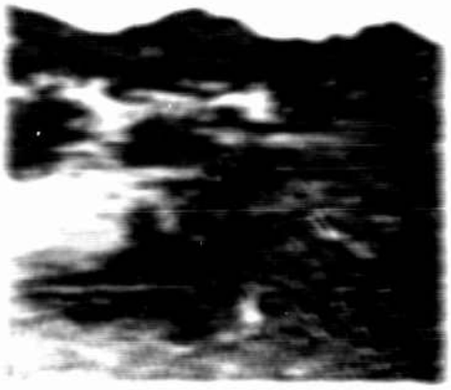
nge at Yuma | Range in the Mexican Desert | World-wide Range

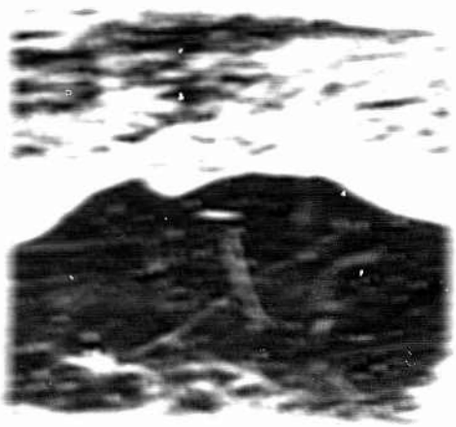


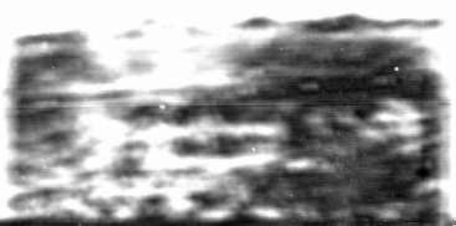
surface condition and mapped in terms of surface roughness or microrelief rather than geometry ranges. Desert pavement occurs a thin rock fragments on alluvial or residual surfaces. Slopes of the surfaces may vary from flat to gently undulating. Constituent particles may several inches.

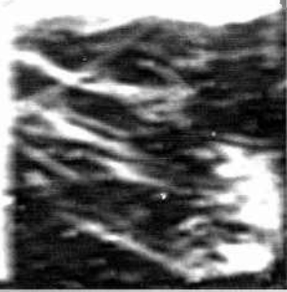


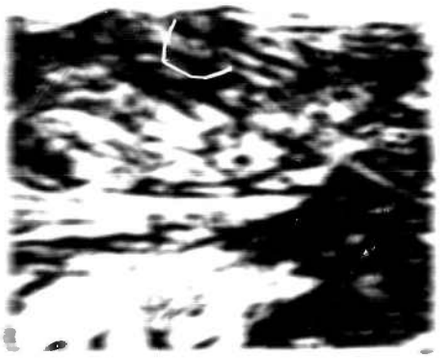
PHOTOGRAPHS

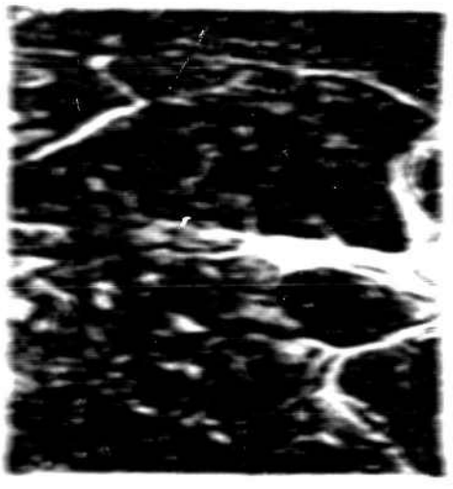


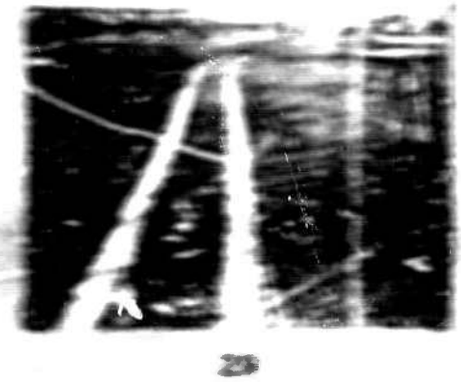






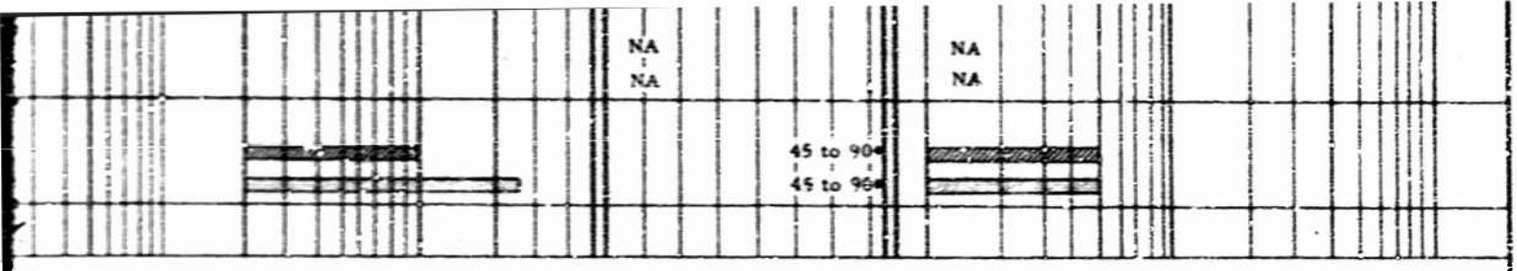




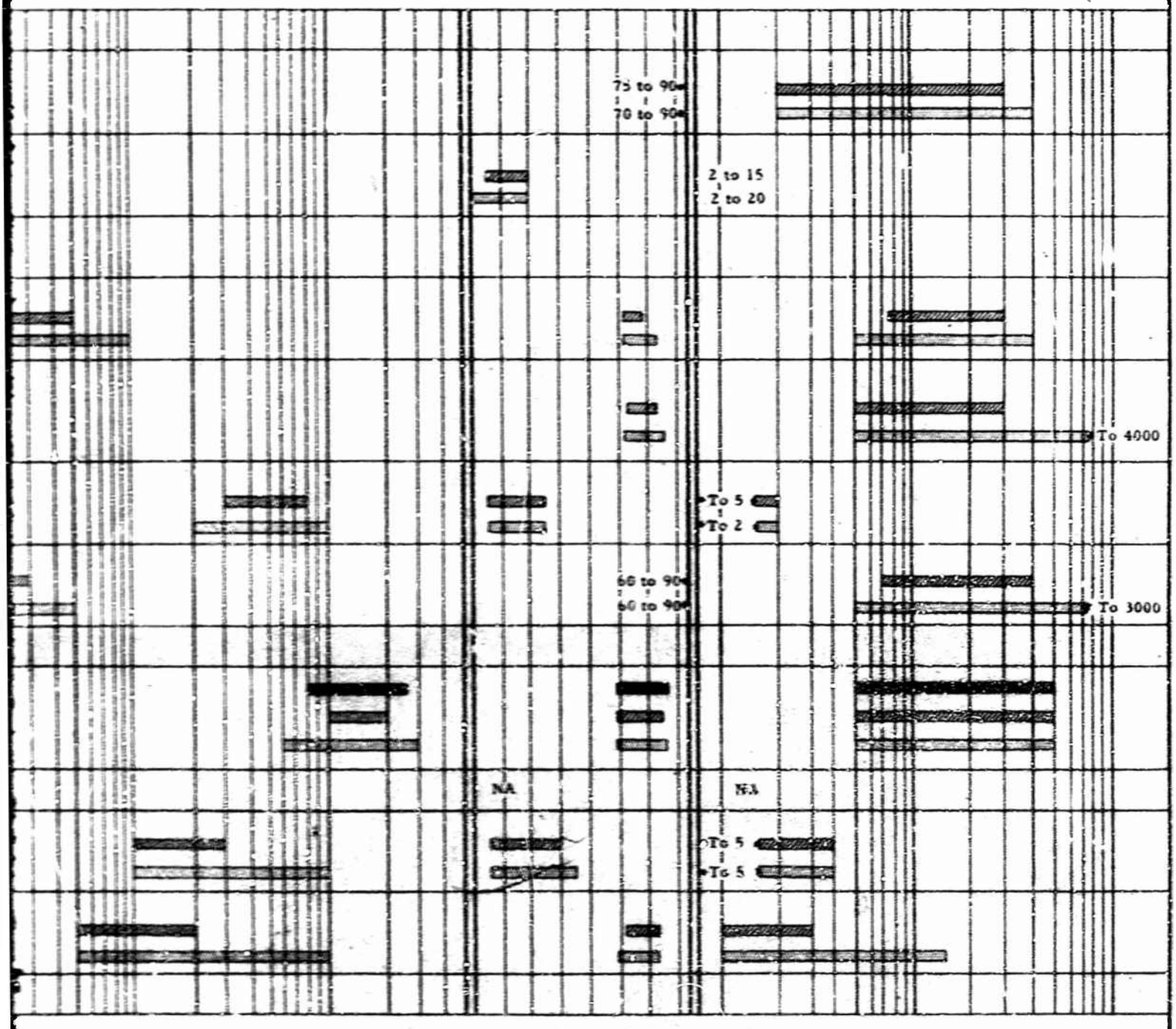


No.	Landform			
	... [illegible]	NA NA	NA NA	
28	Steep wash banks: Steep wash banks are mapped where a conspicuous number of outlines bordered by high precipitous banks occur. Where wash banks are higher than 100 feet they are considered escarps.	11 1, 11, 11.7		
	WIND			
29	Desert pavements (antiduna): Desert pavement is a mosaic of closely packed pebbles and broken rock fragments usually coated with a stain or crust of manganese or iron oxide.	This phenomenon is classed as a surface … cover of closely fitted gravel or rock fr… exhibit maximum diameters of several i…		
	MARINE			
30	Wave-cut cliffs: Steep cliffs of bare rock, or occasionally unindurated materials, resulting from wave erosion marking the seaward limit of the coast.	NA NA	NA NA	
31	Wave-cut terraces: Benchlike, narrow strips of land adjacent to or near the sea which have been sculptured by the waves and currents. Each terrace records a landward advance or lateral erosion.	7, 1 7, 1	2 to 10 9 to 20	
	III. MISCELLANEOUS			
	VOLCANIC			
32	Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash or cinderlike material around a vent.	4 4, 4.7, 3, 5.7, 6, 6.7		
33	Craters and calderas: Bowl- or funnel-shaped depressions of volcanic origin which are more or less circular in plan and bordered by an infacing scarp. Craters are commonly less than a mile in diameter, while calderas have diameters several times larger.	NA NA	NA NA	
34	Broken lava flows: Flat to undulating lava areas characterized by sharp-edged rocks and boulders.	1 1, 11		
35	Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by erosion.	4 4, 41		
	TECTONIC			
36	Basin ranges: Ranges of hills or mountains formed by faulted and tilted blocks of strata (separated by basins).	4 4 4, 41		
37	Swamps: See DRAINAGE, SURFACE WATER	NA	NA	
38	Intermountain valleys: Intermountain valleys are narrow valleys or troughs with interior drainage lying between mountains.	11 1, 11		
39	Mud volcanoes: Small cone-shaped mounds built of clay and sediments formed by the eruption of gaseous and bituminous mud from a central vent or orifice.	4, 5 4, 4.7, 5, 5.7, 6, 6.7		
	RESIDUAL			
40	Grus: The accumulation of countless discrete particles on the surface of granite and sometimes extending to depths greater than 10 feet which have formed from weathering of the various minerals forming the rock.	This phenomenon is classed as a surface c… of weathered granite which may exhibit ma…		
41	Exfoliation boulders: A term applied to boulders whose surfaces have broken or peeled off as scales, lamellae, or concentric sheets.	This phenomenon is classed as a surface c… or rounded fragments of igneous, sedimen…		
	INTRUSIVE			
42	Dikes: Wall-like intrusions of igneous rock which cut across the bedding or other layered structure of the country rock. On eroding they commonly form narrow, sharp-crested ridges which run for miles across country.	41 41 41, 51, 61		

1 Circled map-profile designations indicate great landscapes. * Not applicable.

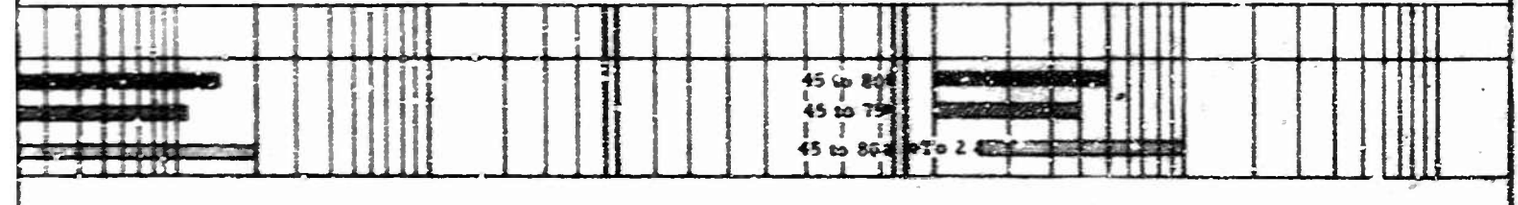


face condition and mapped in terms of surface roughness or microrelief rather than geometry ranges. Desert pavement occurs as a thin
fragments on alluvial or residual surfaces. Slopes of the surfaces may vary from flat to gently undulating. Constituent particles may
inches.



face condition and mapped in terms of surface roughness or microrelief rather than geometry ranges. Grus consists of angular fragments
maximum diameters of several feet.

face condition and mapped in terms of surface roughness or microrelief rather than geometry factor ranges. The boulders may be angular
mentary, or metamorphic rocks. The boulders may range in diameter from 3 inches to a few feet.



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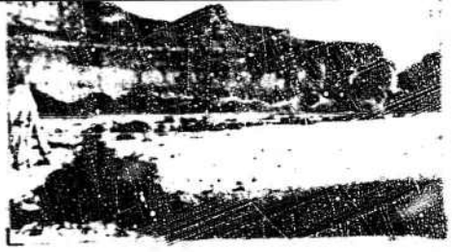

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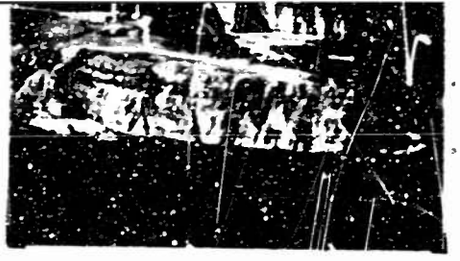

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ANALOGS OF YUMA TERRAIN

IN THE

MEXICAN DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS